FOOD INDUSTRIES

manufacturing and processing

A McGRAW-HILL PUBLICATION—ESTABLISHED 1928

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New York, October, 1929

VOLUME I . . . NUMBER 13

Cleanliness—The Food Manufacturers' Best Friend

REALIZING that throughout the food industries as a group there probably is no more vital necessity than sanitation and cleanliness in the making of foods, it is with considerable assurance that this entire issue has been devoted to that theme. Here will be found feature articles on buildings, equipment, and materials for their fabrication, and certain specific aids to cleanliness, such as detergents and fumigation—all written especially for this issue and with special reference to the needs of sanitation and all that it betokens in the modern food-manufacturing establishment.

For the benefit of all sizes of food manufacturing establishments—large, small, and in between—the house of Lockwood Greene Engineers, Inc., speaking through Clayton C. Westland, tells us of present trends of building construction, many of which are directly attributable to sanitary requirements.

In reciting the sort of equipment that lends itself well to easy cleaning, in addition to functioning in normal fashion, Dr. Burton, of our staff, has assembled material of great help to the practical operative, whether he be superintendent of production or plant engineer.

The extremely lively topic of corrosion-resistant metals and alloys is treated in dispassionate fashion by Charles L. Mantell, an authority on that subject. Although Dr. Mantell's article is concerned chiefly with the needs of the dairy industry, it is applicable in great measure to many other lines of food manufacture.

In his discussion of alkaline detergents, C. S. Mudge surveys the entire field of recent contributions to the problem of the proper use of caustics of all sorts, giving us a fine bit of orientation of this much-studied subject.

Fumigation as an aid to sanitation and the use of ozone and electrolytic water purification are discussed by Harry Stiner and Jonathan Sharp in fashion appropriate to the spirit of the issue. Also in keeping with the general theme is Dr. Scales' report of his original work in struggling with "ropy" milk—a bacterial infection that may be controlled by proper application of bacterial theory.

By all odds the most significant section is that devoted to the symposium on cleanliness and sanitation in the manufacture of practically all the more important foods, market milk heading the list in recognition of the current exposition of the dairy industries at Toronto. This is the work of some eighteen authoritative collaborators in as many fields. The range is wide and all-inclusive, and the findings are invaluable to the sanitary engineer and to the practical worker in the field, whatever be his title.

Beginning the Second Year

AS THOSE who have been reading FOOD INDUSTRIES know, we feel fully assured that the platform upon which we stand is firmly buttressed by solid fact. Our claim that the points of common technical interest among the food industries far outnumber instances of dissimilarity is, we are convinced, a demonstrable truth. We are equally certain that no operating official can read the material that has appeared in our first twelvemonth, asking himself from time to time whether or not manufacturing processes in use in industries other than his own can be advantageously adapted to his industry, without profiting thereby.

So highly individualized has the field of food manufacture become that one quickly loses contact with his brother food manufacturer. That sort of aloofness is detrimental to the best interests of all, for each learns from the other. To serve as the common meeting place for all who are seriously interested in the technique of food manufacture is the happy privilege of FOOD INDUSTRIES; that such a forum for the interchange of ideas was needed is attested by the volume and character of our correspondence with those in the field.

One word of caution have we for prospective subscribers, and it is this: those who derive the most benefit from FOOD INDUSTRIES do so by reading it; an odd statement, perhaps, to make concerning a printed page, but by no means so uncalled for as it may sound, in this day of skimming over relatively vast quantities of periodical matter in relatively little time, with the consequent necessity of merely glancing at illustrations and scanning titles hurriedly in lieu of real reading. In our travels about the country the well-thumbed copy of our journal on the desk of the plant superintendent is the thing that does our hearts good—and those instances are of sufficient frequency to lead us to believe that our present audience will long continue with us.

Present-Day Trends in

Food Factory Construction

By CLAYTON C. WESTLAND
Lockwood Greene Engineers, Inc.
New York City

THE ever increasing demand for processed foods is rapidly developing the manufacture thereof and at the same time increasing competition, with the result that the success of present day food manufacture depends on the production at relatively low cost of a large volume of high quality merchandise, sold on a narrow percentage of profit. Realizing that the plant has great influence on the volume, quality, and cost of the goods produced, the food industries are becoming more exacting as to the matter of housing, with its accompanying necessity for better plants.

When a new building is contemplated the first consideration is the amount of money to be spent, an expenditure composed of two items: the basic requirements of the enterprise and the investment in ornamentation and appearance. It is important to remember that the initial cost of a building is not always representative of its ultimate cost. First cost should be kept low and yet not so low that repairs and depreciation will make the actual cost higher than that of a building requiring a larger initial expenditure. Nor should it be forgotten that a building that may be adapted to another process or a different industry provides a better investment than one suitable only to the requirements of the original occupant.

As to the moot point of investment in ornamentation, some manufacturers absolutely refuse to spend money for structural or architectural treatment that would improve the appearance of their buildings and enhance their advertising value. This stand may be reasonable enough in other industries but not in the food industry. In the making of foods an attractive, well-kept plant, regardless of its location, has an undeniable sales appeal.

In the same fashion that a business concern is judged by the character of its advertising, so may it be said that the quality of a product is reflected in the character of its home, a notable example of this being the "Life-Savers" building at Port Chester, N. Y. At small extra cost the owners obtained a building which through its simple beauty has proved to be a profitable advertising investment.

To make a building architecturally attractive and not greatly add to the cost, attention should be given to proportion and mass. Much can be achieved at little expense by care in design. The original investment in buildings must strike a happy medium and it should not be so large that the resulting building will not yield a fair profit over a period of years. In this connection it will be seen that the type of product largely governs the type of building. For instance, a cannery with its seasonal business will not justify as fine a type of building as a food factory that operates more constantly.

The three steps in the production of any building are layout, design, and construction. To obtain a building which will fulfill all the requirements and prove a good investment, it is necessary that each step be taken care of by those thoroughly skilled along the various lines. This applies to small plants as well as large ones, because these elements have as much relative importance in the success of a small unit as in that of a large one.

Visitors' room in a Borden Farm Products plant

Among the details preliminary to construction is the selection of the proper location and the building site. A study should be made of the proposed general location of a plant in order to find its limitations. Such factors as the supply of power and labor, access to raw materials, water supply, distribution of product, climate, and others must be estimated accurately. The desirability of the site will depend upon the restrictions imposed by building codes, foundation requirements, and the dimensions of the lot as compared with the dimensions of a suitable building for the process to be housed.

After the limits of the project and the location have been determined, sketch plans and preliminary estimates are prepared. A budget should be prepared showing in detail the amounts allotted to the various divisions of the work. The budget is consulted in the letting of contracts, adherence to it securing the correct investment in each of the details composing the building operation.

After the money expenditure has been decided and the site selected, the actual layout of the building is begun. Here the manufacturer may save himself money and trouble by planning his complete building in detail, thereby avoiding errors in design that would lead to expensive changes and alterations later. Material-handling facilities, routing, and the arrangement of machinery and equipment should be determined before the final plans are started. The different departments should be laid out in detail with aisles of proper width, provision being made for adequate clearance between machines and walls. In short, the machinery arrangement should be so made that the cost per machine housed is not excessive. Because of the waste space around the machines, it sometimes happens that a layout making the building cost the least is not always the most economical.

There is a definite relation between

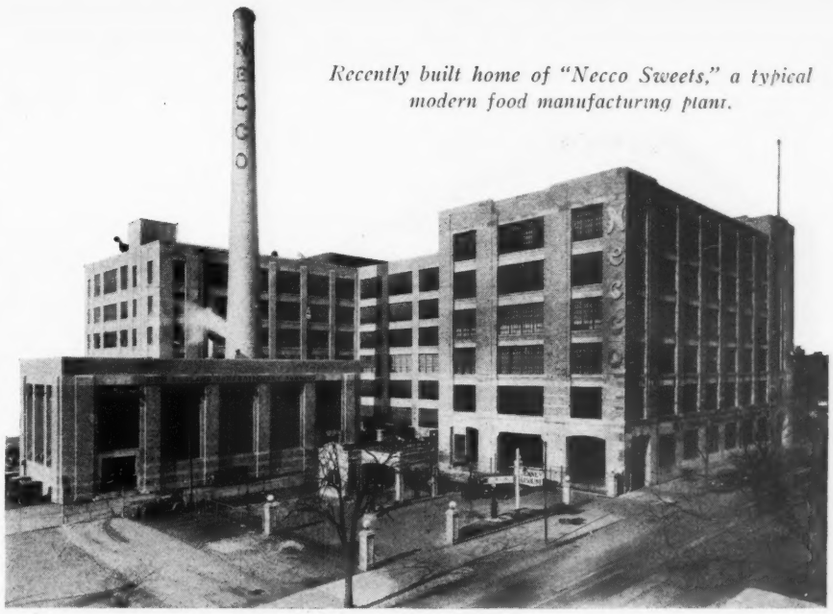
the locations of the storage and the shipping departments, features that should provide for the most economic assembly of materials and the minimum handling of stock in process. The type of routing in a food-producing unit is determined by the nature of the finished product, the character of the raw materials, and the requirements for communication between departments. Vertical routing has proved advisable for many food-manufacturing plants because the materials could be readily elevated to storage on the top floor of the building and proceed thence by gravity through the different steps of the process to the packaging and shipping departments on the first floor. This scheme must be modified occasionally and it may even become necessary to revert to horizontal routing, with the complete process on one level.

The possibility of future extensions, increases in capacity, and changes in process must be considered if the layout is to be successful, for if these items are not allowed for there are likely to be expensive alterations when expansions take place. The most efficient plants are so laid out that extensions will not disturb the first arrangement.

Among the advantages of the ideal layout of a plant are minimum labor, power, and maintenance costs, and the correct economic investment in buildings and equipment. It also reduces the inventory for work in process and effects an ease of "inventory controls." It is possible to create large economies in labor and power by routing materials properly, the substitution of power for hand work, the use of gravity for material movements, and the taking of precaution against power transmission losses. It is necessary to make many sketches and studies before the ideal layout is achieved and even this cannot be used if it provides for a building that will be too expensive.

Preliminary to the design of the structure the engineer must locate the building on the site correctly and at the proper elevation. This assures best arrangements for drainage, railway sidings, trucking, employees' exits and entrances, and daylight. Expansion of the industry also must be considered and the best possible use of the ground should be made with a view to future extensions.

Requirements inherent in cleanliness and sanitation determine the structural features of the modern food-producing plant. The type of construction lending itself most readily to these requirements is reinforced concrete, although for many products the ordinary brick and timber building has been used to advantage. The concrete building has become increasingly popular for such plants as flour mills, candy factories, cereal plants and bakeries. Among the advantages of this construction are permanence, low maintenance costs, rigidity, and adaptability to heavy loads. A concrete building also is substantially fireproof, although insurance rates for the various types of construction do not vary greatly if each has automatic sprinkler equipment. In compact city districts, the building regulations often require fireproof construction, in which case reinforced concrete becomes a necessity. If it is decided to have a more attractive front than is ordinarily presented by this type of construction, a face-brick veneer may be added at little extra cost.



Recently built home of "Necco Sweets," a typical modern food manufacturing plant.

The valuable features of a concrete building include walls, ceilings, and floors that present the smoothest and cleanest interior. Many owners complain of the "dusting" of concrete floors after operations begin. This may be offset by the installation of special cement floor finishes by companies engaged solely in this line of work. A degree of benefit has been obtained also by the periodic application of some types of chemical floor hardener.

There are specific cases where concrete floors are not advisable and among these are processes in which acid is used. In this event acidproof tile or acidproof mastic asphalt should be applied, and to be satisfactory the work should be done by those experienced in this line of work.

If a wood floor is preferred, great care should be taken in its installation. When placed on a concrete base a cinder and asphalt course should be laid first to prevent the rotting of the wood. Maple flooring is most suitable for food factories, and this should be carefully selected and well laid. It should be kiln dried and so laid that there are no open joints or holes where food may penetrate and sour. When a ground bearing is available and a wood floor desired, it may be obtained by use of what is termed a "tar-rock floor." This is composed of a layer of crushed stone and tar, a layer of sand and tar, a course of 2-inch creosoted plank and maple flooring for the surface. This is an inexpensive type of construction, very satisfactory in cases where there are not extremely heavy loads or excessive vibration.

The facilities required by the process used will influence the design of food factories. Therefore the correct design will not only secure a clean and sanitary plant but insure minimum erection and maintenance costs.

In order to get the lowest price from a contractor, it is necessary to have available in advance plans and specifications, complete in every detail. Trading on the obscure requirements of incomplete plans generally causes the owner to lose either through high cost or poor quality of work. The contractor can make his necessary reasonable profit on the work without extra cost to the owner if he knows from the beginning what has to be furnished.

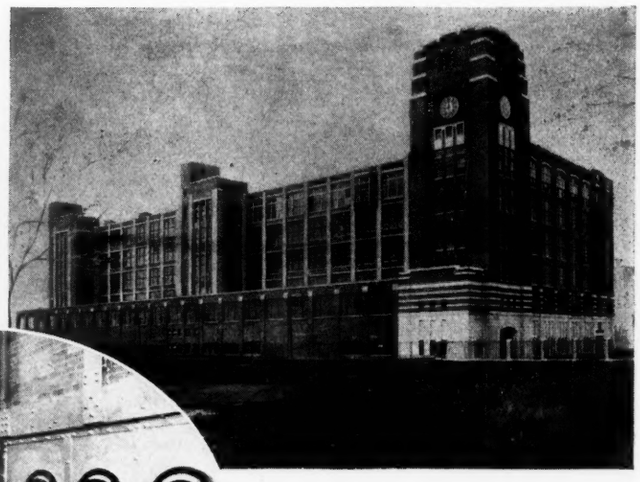
A striking example of a modern food-producing unit is the Schrafft candy factory at Charlestown, Mass. This building is reinforced concrete throughout and covers a lot 200x480 feet. The main portion of the building is 6 stories high, the other sections being 4 and 5 stories. A very attractive front is produced by combining face brick with artificial stone trim and tile spandrel walls. The top of the tower is 160 feet from the ground. The total factory floor space is 675,000 square feet and in addition there is a separate boiler and power plant. The concrete floors have a special cement surfacing in some sections of the building and tile surfacing in other parts, where required for special processes. The roof is concrete with a 5-ply asphalt roofing placed on cork insulation to prevent condensation. There also is cork insulation in portions of all stories on walls, ceilings, and floors. The offices and showroom on the 6th floor are finished in oak; there is a dining room for 3,000 employees, decorated after the Egyptian fashion; as well as an analytical and control laboratory.

The modern flour mill is represented by the Swansdown cake flour plant. Here again we see reinforced concrete used to advantage. This building has reinforced-concrete floors and columns and face-brick walls for pleasing contrast. This inexpensive type of construction is attractive because of good materials used, good workmanship in their installation, and the use of correct proportions in the design of the building.

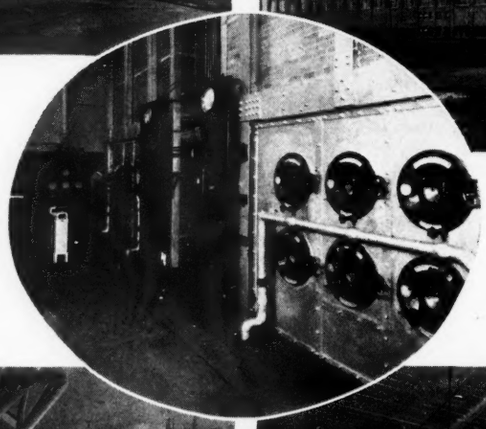
Yet another construction is presented

Modern Construction

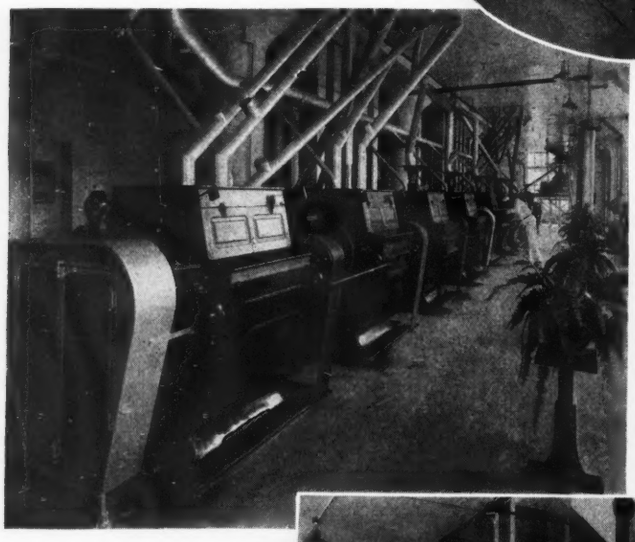
ABOVE—*The home of Life Savers is an illustration of the good appearance obtained by small extra investment over the basic requirements of the enterprise.*



ABOVE—*Where Schrafft candies are made in Charlestown, Mass., a successful combination of reinforced concrete with face brick and artificial stone.*

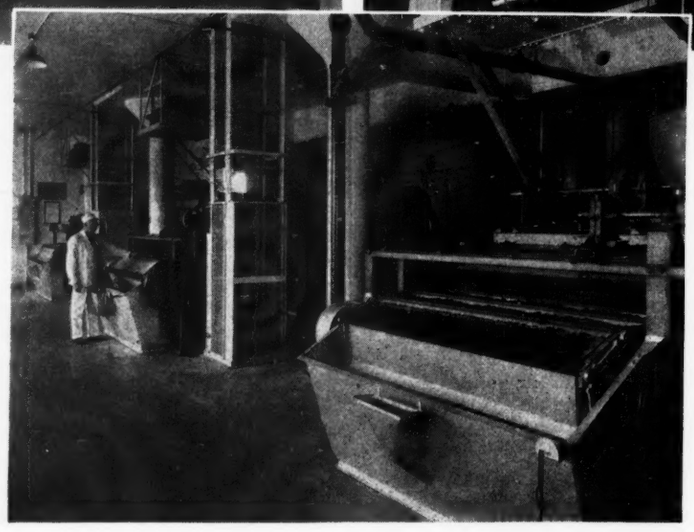


RIGHT—*Oil-fired boilers in the New England Confectionery Company's Cambridge plant insure cleanliness and freedom from ash and coal dust.*



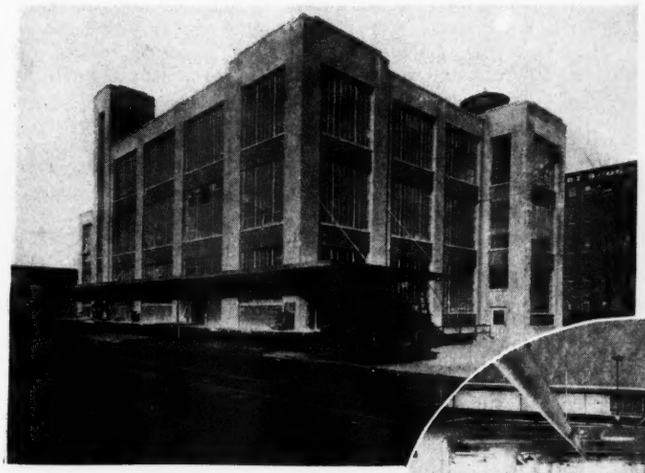
ABOVE—*In this flour mill, where Grape-Nuts originate, floors, ceilings, walls, ducts, piping, and machinery are designed to facilitate cleaning.*

ABOVE — *A section of Schrafft's fancy package department, the total capacity of which is 100,000 pounds per day. Surroundings such as these encourage cleanliness and good workmanship in the employees. In addition to complete process equipment, the plant contains cold-storage rooms, a box and printing shop, dining and recreation rooms, and the offices of the company.*



RIGHT — *The baking of Grape-Nuts is done under conditions conducive to cleanliness of employee, building, machinery, and equipment, as is shown by this view of the discharge end of the secondary ovens.*

Encourages Cleanliness

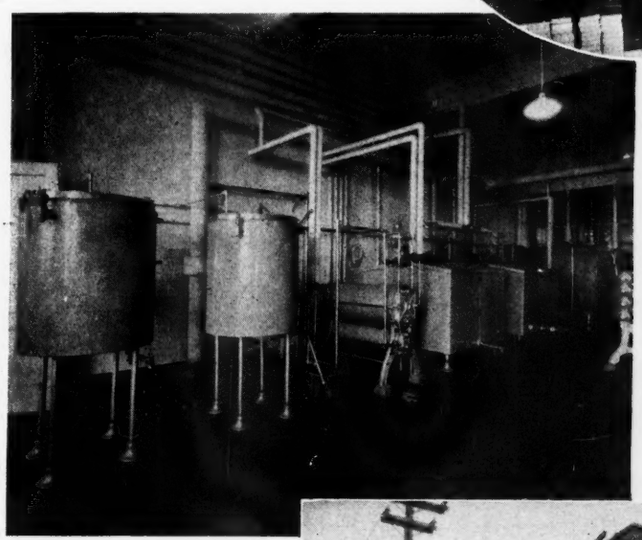


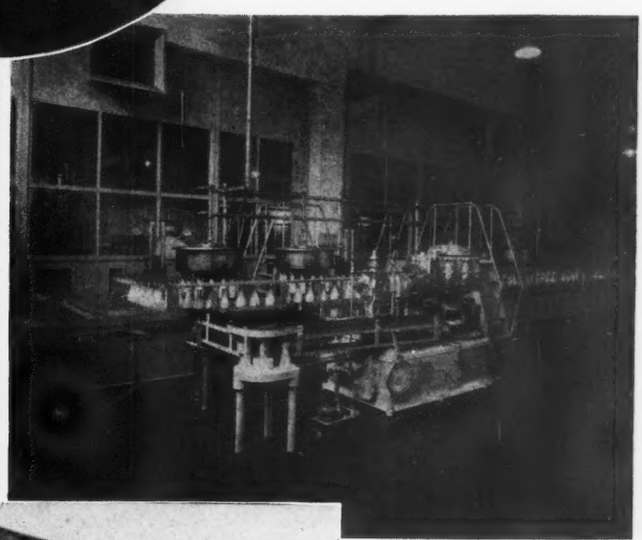
ABOVE—*Reinforced concrete columns and floors with brick walls used successfully in the packaging building for Swansdown cake flour.*

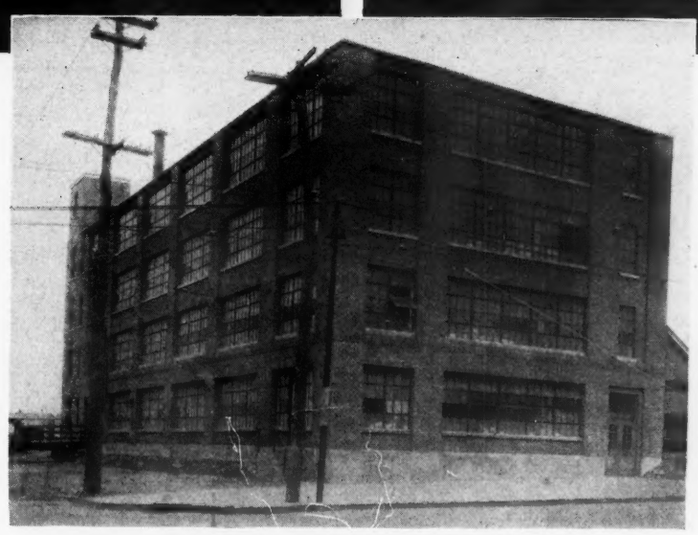
RIGHT—*The stock room of the New England Confectionery Company is air conditioned.*

ABOVE—*These fine structures of the Grape-Nuts and Postum divisions of General Foods Corporation, at Battle Creek, Mich., are designed for maximum efficiency of operation, sanitation, cleanliness and light.*

BELOW—*Properly drained, acidproof brick floors and white tiled walls present a clean and sanitary interior in this Borden Farm Products Company bottling room.*







ABOVE—*Pasteurizing room of a Borden Farm Products Company unit, equipped with acidproof brick floor, to offset action of the lactic acid, and tile on the walls to a height of 7 feet, as the most effective and economical way to combat moisture conditions, which damage paint.*

LEFT—*Brick and timber mill construction was used to advantage by Coughlin Bros. Company, Syracuse, N. Y., for complete candy-making unit, with cream work on fourth floor, pan room on third, hard candy on second, and chocolate work, packing, shipping, storage, and office on first floor.*

by the Postum and Grape-Nuts buildings. These buildings have concrete floors, columns and walls, with a brick veneer for an attractive front. This construction is relatively common, its increased cost as compared with ordinary reinforced concrete being offset by a more dignified exterior.

A different problem is presented in the design of such a building as a cheese factory. A plant of this nature is dependent to a large extent on the nearby surrounding country for its supply of raw material. Small units usually are advisable, and in this event a concrete building is likely to prove too expensive an investment. A novel design was effected in a small cheese factory in Illinois. This building, 40x80 feet, was constructed 4 stories high with the 2 lower stories of concrete and the upper stories with steel columns and timber and plank floor to reduce the cost. The plant, as thus constructed, is a complete unit containing the process equipment, laboratory, culture room, and business offices.

The Coughlin Brothers plant shows standard brick and timber construction, somewhat less expensive than concrete but very satisfactory where long spans are not required or where the floor loads are comparatively light. Where it is necessary to have a more rigid building, brick and timber may be combined with steel columns and floor beams, with the result that a very substantial building is produced at a moderate cost.

The Coughlin building is 50x112 feet, 4 stories high, with the heating unit in a separate building. This is the so-called mill type of construction, having brick walls with heavy timber floor systems supported on Lally columns. In view of the products of the factory (salted peanuts, peanut brittle, marshmallows and other candies), several special features were installed, such as high-pressure steam for cooking and process work, refrigeration, and hot room.

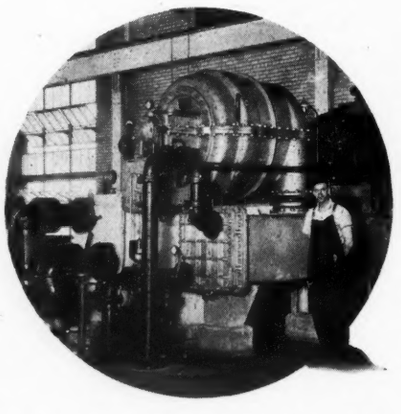
The New England Confectionery plant presents another modern candy factory in which reinforced concrete is the main construction material. The street faces have a brick veneer for a more attractive appearance and the rear of the factory has "rubbed finish" reinforced-concrete pilasters with brick walls. This plant presented problems entirely different from the Schrafft plant due to the fact that the products are of different types. Among the facilities are a dining room for employees and a reception room and salesroom where visitors and customers are received. All material handling is done by mechanical conveyors.

Dairies of the past required a more specialized building than almost any other food process and the pasteurizing and special equipment required layouts and structural designs that became obsolete when this equipment was modernized. A more or less permanent construction for these plants has been developed recently due to the stabilization in the design of their equipment. The most successful construction for this type of building is a combination of brick walls, steel columns and floor beams, and cinder concrete floor systems. This is a heavy, rigid style and has proved advisable because of the ease with which changes may be made in equipment and piping locations. The modern dairy is typified by the plant of the Borden Farm Products Company at Newark, N. J.

The floors in a milk-handling plant present a special problem. Lactic acid affects concrete, and to offset this an acidproof tile or brick must be used to surface the concrete base. It is highly necessary to waterproof the upper floors of any building in which water remains on the floors. This is particularly advisable in a milk plant and the floor should be waterproofed during the course of construction. The preferable method is a membrane layer of waterproofing material through the entire floor, although more or less success has been obtained with the integral type, which is installed by the addition of a mixture to the cement or concrete while it is being poured.

Often it is necessary to have a harder wearing surface even than is presented by concrete floors, especially in shipping and storage rooms where heavy cans are rolled on edge. Here the best scheme is to install steel plates in the concrete as it is poured.

The walls of a dairy present a difficult problem and one for which the correct solution has not yet been found. The steam and moisture found in these plants act on the paint with the result that unless the walls and ceilings are frequently repainted they present an unsightly and unsanitary appearance. This has been offset in some cases by the installation of white glazed tile, but this entails too great an expense if the whole wall is covered. A more economical arrangement is to have the walls tiled up to a height of about 7 feet, thereby affording ample protection to those sections of wall that are subject to the greatest splashing. The idea is well shown by the interior of the Borden plant pasteurizing room.



Refrigeration unit in a Schrafft candy plant

Proper working conditions for employees, no longer of sentimental or humanitarian import, have developed into an economic necessity; particularly so in the food industries. The modern food manufacturer realizes that there is a very intimate relationship between his production and the living and working conditions of his workers, and to encourage cleanliness and satisfaction in them he installs such features as comfortable rest rooms, locker rooms, maximum window areas, hospital rooms, and adequate toilet and washroom facilities.

The location of stairways, toilet rooms, washrooms and rest rooms is very important and it is generally desirable to have no direct connections to them from the factory workrooms. A better plan is to have these features open off a corridor, which in turn opens into the workroom.

Floors, fixtures, piping, washrooms, lockers, flues, air ducts, windows and skylights should be designed to give the maximum sanitation. It is found that with these surroundings the employees not only do better work but take a degree of pride in their place of employment.

Problems that are different in almost every plant are presented when considering heating, ventilation, and refrigeration. Oil-burning equipment is being found advisable because of its cleanliness. Coal and ash dust are eliminated by this method and the modern food manufacturer is installing this apparatus unless conditions forbid its use.

The process in use must be considered in the design of a heating installation. Some processes give off heat, and in these cases the necessary supply of fresh air must be figured and equipment installed which will furnish this, together with exhaust which will keep the atmosphere suitable for working in all kinds of weather.

One of the features of the modern factory is automatic temperature regulation. This equipment is composed of a series of thermostats so gaged that they insure an even temperature throughout the heating season, a result practically impossible of accomplishment by hand regulation. In order to insure uniform freshness of air where large numbers of people are employed, ventilation equipment should be installed, in addition to heating apparatus.

Another feature of modern factory design is the treatment of incoming air, accomplished by a central-station air-conditioning system that provides for warming and washing the air, or cooling it when necessary. Air is delivered to the departments through rectangular metal ducts located close to the ceilings. To be sightly and sanitary these ducts must be worked out as a part of the building and not left until later when their installation is much more difficult.

Some idea of the power-equipment installation necessary in modern food plants may be gained from the installation in the Schrafft plant, the total yearly demand of which is 160,000,000 pounds of steam. It uses 3,000 to 4,000 pounds of steam at 90 pounds pressure per hour for some cooking operations and 13,000 pounds of steam at 6 pounds pressure for other cooking operations and heating. For air conditioning and cooling 550 tons of refrigeration is fur-

nished by chilled water and 150 tons of refrigeration for the cold storage room is furnished by brine.

The average factory building of today is well built, but few repairs being necessary if the building has been well designed and the proper materials used in its construction. However, the paint problem is one that constantly arises and is particularly important to the food plant. For obvious reasons the interior of a food factory must be kept white and clean. In order to do this it is necessary to repaint at relatively frequent intervals, and here the owner may save himself money by doing the job properly. Improperly executed painting contracts are among the greatest sources of difficulty in the construction and maintenance of the modern plant.

The surfaces should be well prepared before the application of the paint. All rust, dirt, and grease should be removed and the surface left perfectly dry. Iron and steel require a priming coat of red lead before the white is applied. Galvanized iron should be given its own special priming coat. The white paint used should be of high quality, capable of withstanding many washings without losing its original whiteness.

Whether or not a building is properly lighted has a direct bearing upon net profit. Some processes require more light than others, depending of course, on the product. A study should be made to show whether some places have too much light and others not enough. This problem is not always considered seriously by the layman, but it should be remembered that improvements in product and production frequently are effected by furnishing additional light in certain places; on the other hand, money may be saved by reducing light where circumstances permit.

The size, spacing, mounting height and type of fixture should be determined for each operation, all according to the improved standards of modern practice. Power and lighting installations should be designed by none but competent engineers. There is great danger of production and actual money losses due to the installation of poor material, or improperly designed electrical equipment.

In summary one may safely say that the properly designed and constructed building is a joy to its occupants and a source of profit to its owner.

FUMIGATION *Has a Definite Place In Factory Sanitation*

By HARRY STINER
National Biscuit Company

AT first thought it would seem that fumigating with some invisible, pungent, and often deadly gas would not be just the proper thing to prevent insanitation around a food manufacturing plant; nor is it in some ways. However, the ever-present hordes of putrefactive and pathogenic bacteria, as well as the many forms of unsightly and odoriferous molds and yeasts which find favorable conditions here and there throughout the plant, frequently can be controlled by fumigation much more expeditiously and cheaply than in any other manner.

Fumigation will seldom completely sterilize filthy, water-soaked floors, or neglected pools of liquids, but it will destroy the millions of militant organisms constantly produced by such places for general distribution. It will check their development around machinery and in cracks and crevices in the walls, where small particles of moist organic matter collect. It also will control insect infestation, thus eliminating one of the most positive as well as undesirable vehicles of distribution.

Canned and bottled foods usually are sterilized before or after sealing, which effectually prevents their future contamination, but such foods as cannot be thus treated, are subject to developing infection even though sealed, unless very carefully protected during their preparation. Moist materials marketed in unsealed packages as well as such articles as bread, cookies, cakes, meats, cereals, and chocolates, though comparatively dry on the surface, will often, due to their fat content or affinity for moisture, develop mold spores they have carried with them from the factory.

Fumigation cannot prevent all microorganisms from arising in manufactured foods, mainly because of their denseness and the fact that most raw materials are more or less contaminated before arrival at the factory. Where the raw foods must be prepared without sterilization, a more careful selection of future supplies will greatly facilitate matters; however, such foods, as well as those with which sterilization is possible, will be much less liable to infection if cleanliness and frequent fumigation are the rule where they are prepared.

Air is a common carrier of bacteria, yeasts, and molds from one place to

Rat inlet; such places should be rat-proofed

another; especially is this the case with moist airs of factories. The different portable utensils used in the preparation of foods collect them from the air, also from being wiped with dirty rags and brushes, or by coming in contact with the floor only to release them when touching the food materials.

Insects, when not controlled, are among the worst pests in factories. Besides destroying much of the material they infest, it is usually rendered obnoxious by the filth they create; and in addition their bodies generally are covered with various micro-organisms. Flies originate in beds of filth that are literally swarming with bacteria, yeasts, and molds; then fly abroad, in their sociable way, to distribute the organisms with which their bodies are covered. A single house fly has been known to carry 800 million bacteria, and still appear normal.

Cockroaches prefer damp, dark spots, and it often appears the filthier the place the better they like it; if a place is not insanitary when they start to occupy it, it soon will be. They hide in sewers, in their nests, or any dark retreat during the daytime, then spend their nights running around. There are many insects such as dried-fruit beetles and pomace flies that develop out of doors in decaying vegetable matter, which, when permitted, contribute their quota to a factory's insanitation.

Rodents are another type of pest common the world over. Large volumes have been written on the disgusting habits of rats and mice and fortunes have been spent on their control. Rodents can be killed, as easily, and with the same gases, as insects, provided all holes in the walls and floors are closed before fumigating, to prevent their escape.

The treating of even a large room with fumigating gas is a comparatively simple matter, when sufficient interest is taken in the fumigant beforehand to learn its peculiarities. However, no single material has yet been developed that can be termed a panacea, because of the large variety of materials to be handled and their reactions to the various gases. Also must be considered the danger from fire and to animal life (including man in some instances), as well as the sensitiveness of some colors and metals.

Many gases have been advocated for micro-organism sterilization as well as for insect and rodent control but cost or inefficiency have prevented most of them from being universally adopted.

Sulphur dioxide, or the fumes of burning sulphur, is one of the oldest fumigants in present use. It has the advantage over some gases of being both an insecticide and germicide, although not the most potent in either rôle. It is non-explosive, but has strong bleaching powers on many foodstuffs and organic colors and also tarnishes most polished metal surfaces. Its penetration into dense bodies is generally slight; besides it requires the presence of moisture to develop its full efficiency, even in the open. Sulphur burns very poorly and therefore should always be accompanied by some other combustible material such as charcoal or cotton wicks. The recommended dosage is 4 pounds of sulphur plus the vapor from 1 pound of water per 1,000 cubic feet of gross space, and an exposure of from 8 to 24 hours. Liquid sulphur dioxide can be purchased in convenient metal containers, which greatly lessen the danger from fires and render it much more convenient to apply; also wastes from incomplete combustion are eliminated. About 12 ounces of the liquid per 1,000 cubic feet is recommended, plus some moisture if the air is dry and the exposure should be similar to burned sulphur.

Formaldehyde, in its commercial form, formalin—a 40 per cent solution with water—generally is considered the most efficient germicide gas in common use. It combines with the protoplasm of the organisms, forming new compounds which prevent the protoplasm from functioning. It is not a bleaching agent nor does it attack most metals. The gas is pungent and irritating to the nose and eyes, but is not considered poisonous to man; and by the same token, it has but little effect on insects and rodents.

Formalin can be generated—gasified—in several ways; however, one of two less complicated methods usually suffices all ordinary requirements. In buildings where heat is used, and can be continued for a period after the place is vacated, upon leaving a mixture equivalent to 12 ounces of formalin and an ounce of glycerin per 1,000 cubic feet of air space can be placed in a vessel over the heat, and the formaldehyde will be thrown off while the mixture boils. Glycerin is added to raise the boiling point and increase the gas release; otherwise a larger quantity of formalin must be used. A more popular method is to generate the gas in a heavy earthen jar with permanganate of potash crystals, in the proportion of 16 ounces of formalin and 7 ounces of permanganate to each 1,000 cubic feet of space, for twelve hours. The permanganate is first placed in the jar and the formalin is poured over it. For best results the humidity must not be lower than 60 per cent and the temperature not less than 60° F.

Heat, aside from its value as a direct sterilizer in liquids, is employed extensively as hot air when and where the materials to be treated and their surroundings are such as will permit the temperatures necessary, 130° F. destroying insects in a half hour, if applied directly. However, this seldom obtains in large buildings, due to air working through the walls and floors and cooling certain parts, or the insects may be deep in some dense, non-conducting material, or on large metal surfaces where the heat is conducted away too rapidly. To overcome these faults, the temperature generally is increased to as high as the materials will stand, and exposure extended to 24 or 36 hours. Hot air seldom is used as a germicide in buildings because of the high temperature necessary to destroy the spores.

Cyanogen, in its various commercial forms, such as potassium, sodium or calcium cyanide, also liquid hydrocyanic acid gas, is the most deadly fumigant for use with all forms of the higher animal life, except mites. It possesses fair penetrating powers, and is considered harmless to most colors and metals; however, as a germicide it is considered of no value. The gas has a strong affinity for moisture, also affects the flavors of some oils and fats. Utmost precaution must always be taken when using cyanide, and only experienced operators should be permitted to handle it. The equivalent of 1 to 2 pounds of sodium cyanide per 1,000 cubic feet of air space, and 12 hours exposure is usually employed in factories and mills; however, when large, moist or dense bodies are to be treated, the dosage must be increased in proportion.

Carbon bisulphide gas is the most popular fumigating medium for insects, especially in interiors. It also is toxic to smaller mammals, but is not used as a germicide. It is very explosive at fumigation strengths, and must always be protected from fires or hot surfaces. The liquid is a strong fat solvent, and the gas affects the flavor of several of the more oily nuts such as pecans, cashews, and walnuts. Its lethal action on insects is slower than cyanide, but

A factory's surroundings should be kept clean

just as sure, and it has the advantage of being toxic to mites. Having no affinity for moisture, its penetration in dense bodies of moist materials is highly efficient, and it does not affect colors or metals.

In tight buildings, at 60° F. or above, the recommended dosage is 3 pounds per 1,000 cubic feet of space, for 24 hours. When below 60° F., the dosage should be increased about 1 pound for each 5 degrees lower. Carbon bisulphide gas usually is generated by placing the liquid in shallow pans above the material to be fumigated; however, where large areas are to be treated, evaporation can be hastened by placing the pans in warm water—less than 175° F.

Ethylene oxide is a comparatively new gas, and as an insecticide is advancing rapidly. It has a higher toxic effect on insects than carbon bisulphide, and is not as poisonous to man. It is considered non-explosive at fumigating strengths, and is much easier to use, being a gas at normal temperatures. Tests have demonstrated its excellent penetrating powers as well as its passive influence on foodstuffs, metals, and colors. Ethylene oxide is sold in cylinders under pressure, which only need opening to apply. Recommended dosage is 2 pounds per 1,000 cubic feet of space, for 24 hours.

Failures frequently happen in fumigating large or even small buildings. Recommended dosages are so closely drawn, due to such reasons as economy, or toxicity, taste, and corrosion hazards, that slight irregularities, like leaky windows, doors, vents, or cracks in the building, low temperature, insufficient humidity, or density of the materials, will often completely counteract all effects of the gas. The same penetrating powers gases may have in fumigation, are used also in escaping from their confinement; therefore the tighter the fumigating chamber is, whether box or building, the longer the gas will hold its strength.

Low temperatures slow down the molecular activities of all gases; they also greatly reduce the movements of insects, which means that less gas is taken into their bodies. In fumigating micro-organisms, humidity is an important feature, for their spore forms are highly resistant to gases when in dry air.

Sanitation covers a broad field. It is also subject to a wide variety of opinions as to what constitutes the condition and how far constructive measures can be carried to accomplish its fulfilment without going to excess. It is universally understood by the American public that human foods should be handled under the most rigid sanitary conditions, but whether in the home or a factory, this degree of perfection is always subject to individual opinion. A concern may permit moisture and débris to accumulate all over the floors and walls, but still consider that its goods are sanitary if handled in carefully washed utensils. Another firm may keep the floors, walls, and machinery scrupulously clean, but still have an unnoticed yet heavy infestation of night running pests, such as cockroaches, crawling over its products and utensils after working hours.

Both of these combinations are subject to similar developments on the finished product, and even though no outward signs of contamination develop on the foods before being consumed, their insanitary condition often is but slightly lessened. Thorough cleanliness in all parts of the factory, together with fumigation for insect pests, rodents, and micro-organisms, can seldom be carried to excess in any food factory that is catering to the approval and welfare of humanity.

CORROSION-RESISTANT

Metals and Alloys in Equipment

A Critical Study of Work Done in the Dairy Industry

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THE last decade has brought forth many new materials of construction in alloys, pure metals, or new thermally modified products. Each in turn has been boomed by its sponsors. Many pages have been written of the resistance to corrosion and adaptability of these materials to dairy equipment, but too large a share of the publicity has been somewhat biased, coming as it has from those who were concerned with selling the metal or alloy, or who were interested in extending its use. In this paper an attempt will be made to correlate data from a number of investigations and summarize the results from an engineering viewpoint.

Practical study of corrosion requires consideration of its economic aspects. Probably the most important object of corrosion tests is to determine the metal for use in construction that will yield the greatest operating profit. Tests are made so that we may learn to avoid or prevent corrosion.

At the present stage of development of dairy machinery or equipment, milk comes in contact with metal surfaces from the time of its production, through the various stages of handling and manufacture, to the packaging of the finished product for market. Experience in the use of diverse metals for the handling of milk has demonstrated marked differences in their performance as construction materials. The suitability of metals is not confined alone to properties dealing with structural features, heat conductivity and durability, but also demands serious consideration of the relations of metals to flavor and keeping qualities of the product.

The factors or properties of most importance in judging a metallic construction material for dairy equipment are many. The metal should be available in all shapes needed. It should be readily workable by all the usual forming and seaming methods. It should possess high mechanical properties as well as the ability to resist abrasion and impact. The material of construction must also be resistant to delayed corrosion, such as corrosion fatigue due to stress or strain or corrosion cracking. It should show marked corrosion-resist-

ance to milk, brines, natural waters, sterilizers, and cleansers.

The importance of resistance of metallic dairy equipment to corrosion by alkaline washing powders, neutralizers, and chemical sterilizers is well appreciated. Cleaning of such equipment makes the use of alkalis indispensable. The action of the alkalis inevitably influences the resistance of the metals to the milk product, as well as the effect of the metals on that product. The life of the equipment is dependent upon the resistance of the metals to steam treatment and refrigerating brines.

Among the most important considerations is one not usually found as a condition of suitability of a corrosion-resistant material in the chemical engineering industries: the possible effect of the material of construction upon the product to be handled. In the dairy industry the metal must not affect the taste of the milk being processed nor should it, by reason of the solubility of the metal, introduce a toxic effect on humans consuming the milk or milk product.

The metal should be readily cleaned and of such color that dirt and impurities are easily detected by inspection. The corrosion resistance of the metal should be a function of the metal itself, not of protective crusts, films, or scales formed by surface corrosion. These will introduce thermal insulating layers, rendering them less efficient heat-transmission surfaces. Such conditions necessitate the use of large areas and larger equipment, resulting in greater investment, operating charges, and building and floor space.

The metallic materials of construction for dairy equipment which have been used in the past or present, or which show possible usefulness, are many. Included in the list are aluminum, copper, iron, nickel, tin, and zinc in the class of single metals; galvanized iron, tinned copper, tinned iron in the coated metals; chromium steels, the nickel-chromium steels, Monel metal, and nickel silver among the alloys.

It is generally recognized that corrosion of metal affecting the quality of a dairy product must involve the possibility of its entering into solution. Such solubility may result from the attack of acids, mineral salts, and other constituents of the milk, as well as from contact with washing powders, chemical sterilizers, brines, mechanical cleaning aids, and the like. It may be caused by electrolysis set up in the product itself, or by stray electric currents. Air, oxygen, and oxidizing agents have been found to intensify corrosion, making the effect at the air-liquid line and similar points of air contact particularly marked. Injury to the flavor and keeping quality of the dairy product may be caused by the presence, even in very minute quantities, of the metallic salts themselves, which have a metallic, bitter, puckery flavor; or by oxidizing or catalytic action of these salts, or by the selective influence of some metallic salts on certain bacteria. Furthermore, it has been shown that the salts and oxides of certain metals have distinct toxic properties, rendering the product unsafe for consumption.

In general, various investigators have tested the metals in small strips, immersing them either entirely or partly in the several liquids under test. Some investigators employ agitation, others closed vessels, still others open beakers.

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There seems to be little agreement as to standard methods of testing. It is recognized that it is somewhat dangerous to attempt to translate results obtained in beaker tests into prophecies of what will happen with large-scale equipment. Nevertheless, small-scale tests will give indications of the possible advantages of one material of construction over another.

As far as the flavor of milk products is concerned, iron has proved itself the most disastrous of any of the metals tested. When in contact with milk and milk products, it causes a pronounced metallic flavor and in some cases putrefactive decomposition accompanied by foul flavor and odor. It is readily attacked by weak organic acids and shows excessive weight loss when used in connection with milk products. It is believed that the exposure of iron under any conditions to milk products should be condemned.

Zinc is an unsuitable material for dairy equipment in that it is readily attacked by milk and milk products as well as the various cleansers, brines, and chemical sterilizers.

The coating of iron with zinc, in the opinion of experimenters, fails entirely to furnish dependable protection. Through the rapid corrosion of the zinc itself, the resistance expected of the galvanized iron is lost. Though zinc produces a metallic flavor in sour milk and cream only, galvanized iron causes a metallic flavor in all milk products. The visible corrosion is very marked on both zinc and galvanized iron.

Under the conditions of testing, copper yields pronounced metallic or related off-flavors. The salts of copper themselves have an intense metallic, bitter taste which follows them in the dairy products. The metallic flavor of copper lactates is so great that less copper is required in solution to give dairy products a metallic taste than is the case with almost any other metal. The presence of copper in even small quantities is capable of producing progressive flavor deterioration in a dairy product with age, due to oxidation and catalytic changes.

Iron heavily coated with tin is far superior to either galvanized iron or the unprotected sheet metal. A heavy and uniform coating of tin does give satisfactory protection against corrosion of the iron, but perfectly continuous coatings are the exception rather than the rule. It is well known that when iron is exposed, the presence of tin accelerates rather than retards the corrosion. The damage is further increased by the use of strong alkalis in cleaning, as well as sterilizers, both of which attack the tin and thus help to expose the iron underneath. As a result, it will be expected that tinned iron will sooner or later produce a metallic flavor in milk products, the flavor being due to the corrosion of the iron.

It may be concluded that iron, zinc, galvanized iron, and copper are unfit materials for the construction of equipment designed for the handling of milk products. In the case of tinned iron, whenever iron is exposed the material also falls into this class.

Visible corrosion of aluminum when exposed to dairy products was found to be slight, in most cases being confined to a slight tarnish. Only very slight metallic flavors were found in the case of dairy products of high acidity. Aluminum equipment is extensively used in European milk plants in equipment such as pasteurizers, coolers, and holding tanks. The physical state and purity of the milk are of considerable importance. Wrought or rolled aluminum of relatively high purity is decidedly preferable to cast metal. Aluminum, however, is markedly attacked by alkaline washing solutions. This attack may be almost entirely eliminated by the use of washing solutions containing sodium carbonate with small quantities of sodium silicate to act as an inhibitor.

It has been found experimentally by a number of workers that minute quantities of nickel are dissolved by sweet milk, sour milk, and buttermilk. Some of the experimenters conclude from results of test that nickel is not entirely negative as far as effect on the flavor of the milk product is concerned. Reported observations in different commercial plants show wide variation.

Experimental results indicate a possible maximum absorption in commercial pasteurization and storage of sweet milk in nickel equipment of about twelve parts per million. Dark films sometimes form on the surfaces of nickel and Monel metal in milk. They are composed largely of milk proteins, the color being due to a small content of metal sulphide. The films and tarnishes can be readily removed by abrasive cleansers. Nickel stands up very well against the action of alkaline washing solutions, chemical sterilizers, and re-

frigerating brines encountered in the dairy industry. Although, judging from some of the results obtained, nickel perhaps cannot be considered entirely immune from the standpoint of metallic flavor in milk products, under average conditions it is a reasonably safe metal for milk handling. It is stated that tarnishing in nickel, which is one of its drawbacks, can be eliminated in practice by the use of aluminum fittings in all-nickel equipment.

At one time Monel metal was considered the most logical metal for wide use in the dairy industry; but as the result of corrosion tests and other factors, it has been relegated to a few special uses. It appears that Monel metal suffers objectionable tarnishing, and that it also yields copper in solution, with damaging effect on the keeping quality of the products, as already discussed. It is believed that Monel metal does not give dependable protection against metallic injury to the flavor of milk products. It appears that either contact with copper, or the presence of minute quantities of copper in milk, is necessary for the growth of certain strains of bacteria which produce off-flavors. The action of washing solutions, chemical sterilizers, and refrigerating brines on Monel metal is very slight.

The copper-zinc-nickel alloy, nickel silver, has proved more damaging to the milk product than Monel metal. In addition, nickel silver tarnishes considerably in some of the alkaline washing solutions, but satisfactorily resists the action of chemical sterilizers and refrigerating brines. It is believed, however, that nickel silver is not a satisfactory material of construction because of its tendency to tarnish and its injury to the flavor of the majority of milk products.

Tin has been found not to produce any metallic flavor whatever in any of the milk products under test. Although tin is appreciably soluble in milk, the salts of the metal appear to cause no noticeable injurious effect either on the flavor of the product or in starting progressive decomposition and damage, such as those caused under identical conditions by iron, copper, and nickel silver. Tin is more soluble than copper and copper alloys, yet it is known that ten times as much tin is required in solution as copper to produce a metallic flavor. Tin has the disadvantage, however, that it is soft; it may be readily worn by friction. It is attacked by alkaline washing solutions, although not so much as aluminum. This attack may be reduced to almost a negligible degree by washing with solutions of tri-sodium phosphate containing small percentages of sodium chromate. Tin is slightly attacked by the chemical sterilizers and by refrigerating brines, in which case, however, its performance is satisfactory.

Properly tinned copper of the heavy coating type shows all the advantages of tin with none of the disadvantages of copper, as far as effect on flavor of the products is concerned. A complete and heavy tin coating on the copper provides the most effective protection against the corrosion of the base metal and its damaging effect on the milk product. Properly tinned copper offers a safe surface for exposure to milk products. Retinning is necessary at frequent intervals, however, since the life of the tin coating is relatively short. The continued popularity of tinned copper surfaces in dairy equipment is due to the comparative simplicity of fabrication and the relative case of retinning, coupled with the distinct absence of metallic flavors in dairy products held in contact with tin.

From the viewpoint of the experimenters, the ordinary chromium steels of the so-called stainless class cannot be considered sufficiently dependable for all-round use in dairy equipment on the basis of our present knowledge. They seem to produce slight metallic flavors in high acid milk, such as that of the acidophilus type. These steels are practically resistant to the action of alkaline washing solutions and they show no visible corrosion when exposed to any of the chemical sterilizers commonly used, but they are slightly attacked by refrigerating brines. So-called stainless steels having highly polished surfaces resist corrosion better than when their surfaces are unpolished.

The nickel chromium steels of the austenitic type are the only metals other than tin or tinned copper which produce no metallic flavor in any of the milk products tested. These alloy steels show no visible corrosion and no loss of weight when exposed to milk products. The absence of corrosion suggests the absence of solution of the metal, with resultant absence of metallic flavor. Some observers, who before the commercial advent of the nickel chromium steels considered all-tin and all-nickel the only metals suitable, have reported that the nickel chromium steels have proved fully equal, and in some respects superior, to nickel in the construction and use of milk-condensing and sterilizing equipment.

The nickel chromium steels are practically immune to alkaline washing solutions, chemical sterilizers and refrigerating brines of the sodium, calcium, or magnesium chloride type. It is important to note, however, that users of the nickel chromium steels, particularly in the shape of tanks, have learned that when such equipment contains rivets, bolts, fittings, or other accessories of such metals as iron, copper, nickel silver, Monel, and tin, the corrosion-resistance of the alloy may be markedly diminished.

The maximum resistance of these alloys to corrosion depends upon a high polish of the surface. In addition, considerable care must be taken in the fabrication of the equipment, particularly in the production of proper finishes on welded surfaces, and in the elimination of other metals which would form electrolytic couples with the nickel chromium steels.

ALL things considered, equipment made under carefully controlled manufacturing conditions of the nickel chromium steels may be expected to be more satisfactory, as far as absence of corrosion by the various liquids encountered in the dairy industry and absence of flavor in the milk products treated or processed are concerned, than that made of the other metals discussed.

Most of the experimenters seem to give second place to all-tin, all-nickel, and heavily tinned copper equipment. The corrosion of tin and tin plated copper by washing solutions may be markedly reduced by the use of proper cleaners. The tarnishing of nickel also may be eliminated by proper design, such as the use of aluminum fittings. The corrosive effect of washing solutions and brines on aluminum, a metal widely used abroad and thought to have considerable possibilities in American practice, may be almost entirely eliminated by the proper choice of cleansers and refrigerating agents.

Monel metal, nickel silver, tinned iron, copper, galvanized iron, iron, and zinc, either because they affect flavor or because they are corroded by various agents, are considered not to be suitable for general use in dairy machinery. It is believed that Monel metal should be restricted to a relatively small field of use. The chromium steels, in the opinion of the experimenters, show uncertain performance.

Above all, however, it should be emphasized that proper design of equipment is very important, and that carelessness in the specification of minor details or accessories in dairy equipment may introduce corrosive effects offsetting the usual resistance of the metals employed as construction materials.

THE QUALITY *of food in contact with metallic equipment may suffer if improper materials have been chosen; and likewise the equipment itself may suffer either from contact with the food or from the corrosion or abrasive effects of detergents used for cleaning. Dr. Mantell's review of the latest scientific discoveries relative to materials of construction is limited to equipment for one of the most sensitive foods—milk and milk products—but much of the knowledge here summarized is applicable to other lines of food manufacture, particularly in places where the food is wet while in contact with metals.*

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IN RECOGNITION of the imperative need of cleanliness and sanitation in the manufacture of foods of all sorts, the editors herewith present a collective discussion of that important subject, each contribution coming from an authoritative writer.

Market Milk

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CLEANSING and sanitation should be of chief concern to those engaged in the handling of milk from the time the cows are prepared for milking until the final package is placed in the hands of the consumer. These paragraphs deal with the period during which the milk dealer is entirely responsible for the proper observation of cleanliness and sanitation; that is, from the time the milk becomes the dealer's property until he delivers the processed product to the consumer.

The preparation of market-milk processing equipment for successive runs consumes about 20 per cent of the time necessary for one complete operation. Alkaline solutions, which have a saponifying effect on milk fat and a solvent action on other milk solids, supplemented by vigorous brushing and scouring, are the means for rendering the bulk of the equipment physically clean. The caustic-soda type of solutions are rather corrosive to the metal equipment and hence are not used to the extent that the buffered alkalis are employed. In this latter group belong the neutral soda, the straight soda ash, and trisodium phosphate types. To attempt to indicate definite quantities of these products for use without direct reference to specific commercial products is quite difficult. The figures given herein are to be regarded as general average amounts and for use in connection with normally soft water supplies. If it is necessary to use cleaning water having a total hardness—temporary or permanent—of sufficient degree to cause the dissipation of an appreciable amount of alkali in merely softening the water, it would seem that the installation of a water-softening device should receive consideration.

Sterilization of all dairy equipment in the absolute sense of the word is not practical of attainment. Dairy sterilization means absolute freedom from all organisms of pathogenic significance and freedom from all other types to such a degree that the product will not be appreciably increased in bacterial content by contact with the equipment. Sterilization of dairy equipment is variously accomplished by the application of live steam, scalding water, or chemical solutions or sprays containing chlorine in the active state, of which sodium hypochlorite is typical and is used generically therefor throughout these notes. Dairy equipment must be physically clean, however, before sterilization is attempted. This is particularly important when the chlorine type of chemical sterilization is to be applied, as any organic material present will be readily oxidized by the chlorine and the chlorine content available for sterilizing purposes thereby materially reduced.

Ordinarily the dairymen deliver the raw market milk to a receiving station, maintained by the dealer in the production area, and operated for the purpose of accepting, weighing, cooling and canning, or filling milk into thermo-insulated tank car containers. Its equipment customarily consists of a dump or weigh tank with a straining or filtering attachment, a cooler feed tank, one or more milk pumps, a milk cooler, and the sanitary piping necessary to convey the milk through the system and into cans or into a tank car container.

AT THE conclusion of the canning or tank-car filling operation the entire system is flushed out with clean, cold water and then dismantled for the purpose of cleaning with the aid of warm alkaline solution and brushes. This cleansing solution may be made with one of the powders containing tri-sodium phosphate or with one of the neutral-soda products. The weigh tank and strainer, cooler feed tank, cooler, and milk pump are thoroughly brushed with a solution containing about 2 ounces of one of these cleaning products to 10 or 12 quarts of water, the temperature of the solution ranging from 120° to 130° F. After this treatment the equipment is rinsed with lukewarm water and sterilized with scalding water, at 180° to 200° F. Sterilization may be accomplished also by treatment with live steam or by spraying with a solution of hypochlorite showing a chlorine availability of 300 parts per million, or by flushing with a solution containing 100 parts per million available chlorine.

The sanitary piping should be soaked and thoroughly brushed inside and out in a solution made up of approximately ½ pound of the cleansing products mentioned to each 20 gallons of water, used at not less than 110° F. The piping is then rinsed with lukewarm water and the entire system reassembled. Sterilization is now accomplished by flushing the system with hot water at 180° to 200° F., or with a hypochlorite solution of approximately 100 parts per million of available chlorine. The system is then thoroughly drained. The system should be so arranged that complete drainage may be easily accomplished. This is particularly important when chemical sterilization is employed, as these solutions are likely to be somewhat corrosive to some metals and improper drainage would permit overnight contact which might eventually prove quite injurious. After drainage is accomplished, all sanitary connections should be tightened.

It is considered very good practice to give the entire system a sterilizing flush just prior to starting the milk through it in the morning. For this purpose, use may be made of hot water at 180° to 200° F., or, health department regulations permitting, a flush solution of hypochlorite of 100 parts per million of available chlorine. In the case of either sterilizing medium it will be essential to use a volume sufficient to flush thoroughly all parts of the system. If scalding water is used it will be advisable to allow enough time for the equipment to cool before the milk is started through it. Unless the system is so arranged that thorough drainage is obtainable it will be necessary to draw off the first few cans of milk in order to prevent any possible dilution of the product by the remnants of the sterilizing flush solution.

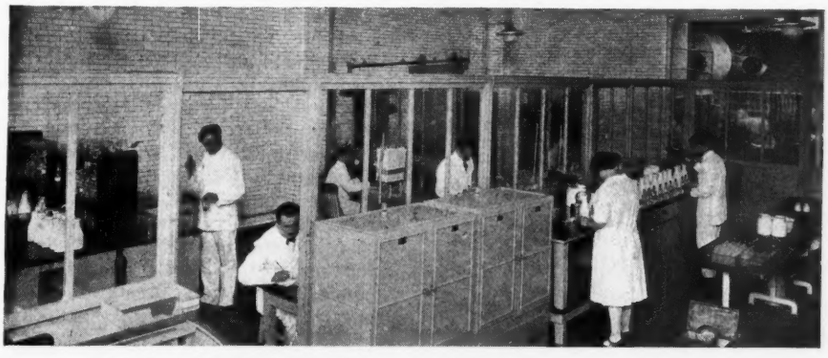
THE pasteurizing and market-milk processing plant presents a more complex situation than is encountered in the case of the raw-milk receiving station. In this instance the heating and processing of the milk and milk products renders the equipment much more difficult to clean because the milk solids tend to become more firmly incrusted upon the surfaces of the processing equipment. The raw milk generally is started into the pasteurizing plant at the dump tank, whence it is pumped over a cooler into a raw storage tank, and there held ready for pasteurization. The pasteurization operation starts when the raw milk leaves the storage tank, passing from there through the heaters, filters, holders, pasteurized milk cooler, and the fillers, where it is converted into the final package. This sequence, with possible minor variations, will hold true for most pasteurizing systems.

That part of the equipment of the pasteurizing plant which is used to handle the raw milk may be cleaned and sterilized in much the same manner as has been described for the raw milk

receiving station. The market-milk pasteurizing plant presents the sterner problem of cleaning and sterilizing milk heaters, filters or clarifiers, holders, pasteurized milk coolers, fillers, all sanitary piping and sanitary connections, pumps, and the like, from the heaters on through the system. At the termination of the pasteurizing operation the practice is to flush cold water through the system from the heaters to the fillers and to catch the milk rinsings, which then may be separated, thus effecting a means of milk fat recovery.

The heaters are filled with a tri-sodium phosphate solution, the powder used at the rate of 1 to 1½ pounds per heater. This solution is applied at about 130° F. and held in the heaters for at least 20 minutes. The heater tubes are next thoroughly brushed with the alkaline solution and then rinsed with warm water. Headers or end doors may be cleaned by brushing with a tri-sodium phosphate solution at the concentration of 6 ounces of powder to 12 quarts of water.

In the heaters the milk is brought rapidly from storage temperature of 40° F. or below to a holding temperature of about 143° F. and if the heaters have been in use for a period exceeding 4 hours the milk stone may not soak off and remove so readily with the ordinary tube brush, in which case it may be necessary to use a motor-driven rotary brush or as a last resort some abrasive material such as steel wool. The use of steel wool is not to be encouraged, but there are instances, as in the case of some types of milk heaters, where the use of some such material seems necessary for proper cleaning. The heater may be sterilized by flushing with hot water at 180° to 200° F. or by flush treatment with hypochlorite at a strength of 100 parts per million available chlorine. In either case the heater should be immediately and thoroughly drained after treatment.



Just how well all the sanitary precautions and cleaning measures are performed is determined daily in the control laboratory.

Milk filters should be disassembled, rinsed with cold water and then soaked and brushed in a solution of tri-sodium phosphate at the rate of 1 ounce of powder to 10 quarts of water at 110° to 120° F. The metal parts may be sterilized with scalding water or by spraying with a hypochlorite solution containing 300 parts per million available chlorine. Just before milk is run through the system the filter cloth bag or filter pack may be put in place and treated with scalding water. If a centrifugal milk clarifier is in use it may be cleaned by rinsing with cold water, soaking and brushing the dirt bowl and connections in alkaline solution, and sterilizing in the manner suggested for the metal parts of the filter.

Positive holding tanks are first flushed with cold water and then scrubbed vigorously with a warm solution of a tri-sodium phosphate powder at the rate of 6 ounces of powder to 12 quarts of water. It may be necessary to scour with dry powder but the application of mechanical abrasives should not be necessary. The tanks are then rinsed with warm water and sterilized by treatment with hot water at 180° to 200° F. or by means of one of the hypochlorite spray solution at a strength of 300 parts per million of available chlorine. Continuous-flow holders may be handled in the same manner as tubular heaters and chlorine application in this case may be by complete flushing with a solution containing 100 parts per million of available chlorine.

How to Clean and Sterilize Coolers and Heaters

EXTERNAL tubular coolers are rinsed with cold water and brushed with a warm 6-ounce-to-12-quart solution of a tri-sodium phosphate product, then rinsed with warm water and sterilized by running over the cooler scalding water at 180° to 200° F. or a hypochlorite solution of 100 parts per million available chlorine. External tubular coolers may also be sterilized by spraying with a 300-parts-per-million chlorine spray solution. Internal tubular coolers are handled in the same manner as milk heaters in so far as the tubes are concerned. The heaters are soaked and brushed with a warm tri-sodium phosphate solution at a concentration of 6 ounces of powder to 12 quarts of water. The cooler is sterilized by flushing with scalding water or with a hypochlorite solution containing 100 parts per million of available chlorine.

Milk fillers are rinsed with cold water, dismantled, and cleaned by brushing the bowl and parts with a tri-sodium phosphate solution of 4 ounces of powder to 12 quarts of warm water. Fillers and parts are now rinsed with warm water and steamed or sprayed with a hypochlorite spray solution. Rubber parts are placed, for a period of an hour, in sterile salt solution the strength of which is 4 ounces of salt to 10 quarts of water. This treatment tends to keep the rubber in good condition. The entire filler is now sterilized by flushing with hot water at 180° to 200° F. or with a hypochlorite solution of 100 parts per million of available chlorine.

Hot milk pumps, sanitary fittings and sanitary piping after being rinsed with cold water may best be cleaned by soaking and brushing in a solution of tri-sodium phosphate powder made up at the rate of 2 ounces of powder to 10 quarts of water and at 110° F. After thorough brushing this equipment is rinsed with warm water and sterilized, after assembling, by treatment with hot water at 180° to 200° F. or by flushing with hypochlorite solution at a strength of 100 parts per million available chlorine.

In the morning before the milk-processing operation is started it is desirable to subject the entire system, from the heaters through the fillers, to a sterilizing flush. This flush solution may be hot water at 180° to 200° F. or it may be a solution of hypochlorite at a chlorine availability of 100 parts per million. In the normal size pasteurizing plant it is advisable to use at least 100 gallons of solution in order to insure a thorough flushing of all parts of the system. After this solution has been completely drained from the system and all connections inspected and tightened, where necessary, the system is ready for the start of the processing operation. It will be found desirable to draw off approximately the first ten cans of milk and thus be assured that all possible remaining water or chlorine solution has been flushed out and has not tended to dilute the finished product. These ten cans of milk may, of course, be separated and the milk fat thus recovered.

Preparing Bottles for Filling An Important Question

THE preparation of milk bottles for filling is a very important operation in the market milk pasteurizing plant. Hand washing of milk bottles has practically fallen into the discard for any except the very smallest milk plants. Of the bottle-washing machines the soaker type washers probably are the most popular. In one of the large metropolitan areas the local health department requires that bottles be immersed in a 4 per cent solution of sodium hydroxide at not less than 150° F. for at least 7 minutes, and during this immersion the bottles must be brushed, properly sprayed or subjected to air or water pressure sufficient to clean them thoroughly.

This treatment is thought to provide a suitable margin of safety in the matter

of bacterial elimination from milk bottles. The bottles are then rinsed with a cold-water solution containing ample chlorine to render each bottle in such state that it will not add to the milk more than one bacterium per cubic centimeter of its capacity. A water solution containing 15 to 20 parts per million of available chlorine has been found sufficient for this purpose. This chlorine water treatment merely serves as a sterile, cold rinse to replace the formerly required scalding rinse and it is not deemed necessary to place any dependence upon it as a medium for further sterilization of the bottles. In this same locality bottles washed in machines other than the soaker types are permitted to be treated with a weaker alkali solution at 120° F. and required to be submerged in, or rinsed with, water containing not less than 50 parts per million of available chlorine. After thorough draining the bottles immediately move on the automatic conveyors to the filling machine.

Some people insist upon using empty milk bottles as temporary containers for paints, varnishes, oils, tar and other substances that are not readily removable even when the bottles are subjected to the very thorough treatment in the soaker type washers. When such bottles find their way back to the milk plant they may be effectively cleansed by hand washing in a 10 per cent sodium hydroxide solution. For this work the plant operator should be equipped with elbow-length protective gloves, a heavy rubber apron, and protective goggles. After these bottles have been rendered physically clean they may be placed in the bottle-washing machines for the regular treatment.

OFTENTIMES milk equipment appears to be well cleansed and sterilized and yet causes bacterial contamination because the sterilizing temperatures or strengths were inadequate, or possibly because some portion of the equipment did not receive the proper attention at the hands of the clean-up squad. A control laboratory sufficiently well equipped to study the equipment from a bacteriological standpoint and to study materials used for washing and sterilizing will prove of considerable advantage to the market-milk plant.

The relationship between equipment and bacterial contamination may be studied in a number of ways. A plan that has worked well for pasteurizing plants is to catch samples of milk from the raw storage tank and then to take samples of the same milk, successively, as it leaves the heaters, filters, holders, cooler and finally as it is delivered from the fillers. The same milk also should be sampled after it is bottled, and standard plate counts should be made on all samples. This procedure will indicate any significant contamination at the point of occurrence.

Samples for studies on the bacterial content of milk containers are acquired generally by flushing the container with a known quantity of sterile water. Quart bottles generally are flushed with 100 cubic centimeters of sterile water, 1 cubic centimeter of which is plated directly, and results are calculated and expressed in terms of contamination per cubic centimeter of capacity of the milk container. Milk cans are similarly treated with 500 cubic centimeters of sterile water, and results are expressed in the same manner.

Examination of large storage tanks, tank car containers, and tank truck containers, by flushing with sterile water is not practical because of the large volume of sterile water necessary and the difficulties involved in flushing all portions of the equipment. Some information may be obtained by catching and plating samples of the condensation water when steam sterilization has been applied but this method is of no value when chlorine spray solutions have been used. A check on a series of samples of the same milk as it enters and leaves such containers seems to be the only really practical method of determining the contamination rate.

Butter

By F. W. BOUSKA
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Beatrice Creamery Company
Chicago

THOROUGH cleansing has been a tradition of butter makers since the very beginning of the industry. Old timers, when working as apprentices, received a strenuous "course of sprouts" in this department. For a long time belief has prevailed that cleanliness is beneficial to the flavor and keeping quality of butter. This belief is supported by present experience. Appearance, of course, always was an important consideration. Modern experience and requirements have brought the sanitary value of cleansing into prominence. Bacteriological methods are used now to ascertain the degree of cleanliness and sterilization of equipment.

Although cream and butter are difficult to clean off with cold or lukewarm water, they are very easy to remove with hot water. A small quantity of detergent is helpful. From the standpoint of cleansing treatment and sterilization, convenient divisions may be based, respectively, on equipment that can be immersed in hot water, and equipment that cannot conveniently be immersed.

In washing cans the best treatment consists of: (1) draining, (2) rinsing, (3) washing, (4) rinsing, (5) sterilizing with steam or disinfectants or both, and (6) drying with hot air.

A good worker with a hand brush and a sink of hot water can produce faultless results by hand. He can apply more scrubbing where more is needed. But such men are hard to find and leaning over a sink of steaming hot water is uncomfortable in the summer. This causes many men to relax on the intensity of scrubbing and often to quit their jobs. In the long run mechanical can washers are the most satisfactory where volume justifies their installation.

F. W. Bouska

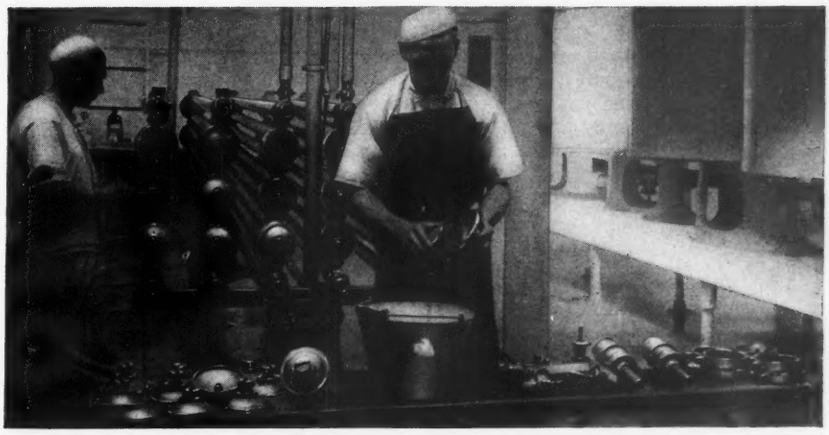
Such a can washer automatically gives the six treatments mentioned. A doser for disinfection with a harmless disinfectant sometimes is added. The usual detergent is a form of sodium carbonate. Tri-sodium phosphate and soda ash are sometimes used. The machine needs intelligent supervision to produce satisfactory results. When properly operated, the cans are clean, dry, and practically sterile. Bacteriological cleanliness is important, for lack of it may cause injury to the product carried in the cans. The detergents mentioned above are sold under proprietary names.

The vats and pipes in which cream is handled are easy to clean but difficult to sterilize. Placing a large volume of hot water containing a detergent and scrubbing with a brush is good treatment for vats. The cleansing of pipes and pumps should be followed by forcing a stream of steam through them. The

EVERY FACTORY MANAGER *who is faced with the problem of grease removal from concrete floors will be interested in the way it is done in a butter factory. Woodenware, much used in butter making, presents peculiar problems of cleaning and sterilizing.*

pressure may be raised to a few pounds by partly closing the outlet of the pipe. For this purpose the pipe should be provided with a pressure gage and a permanent steam connection.

For cleansing starter equipment the same methods apply as for other equipment. Here, however, extreme pains must be used to sterilize the equipment and to avoid contamination afterward. Some sort of device for sterilizing small equipment is desirable. A box or chamber into which steam is admitted at room pressure is commonly used and is satisfactory. The starter maker usually does his own cleaning. The fact that he must be well experienced in this work or that he must have some bacteriological education assures more efficient cleaning and sterilization.



Cleaning internal tubular cooler and parts

In washing churns the first step is the removal of the butter. This is followed by putting in the churn 50 gallons of hot water (not less than 180°F.) and revolving a few times in fast gear with vent open, with no washing powder. Drain quickly through one or both doors to avoid accumulation of grease and scum in churn.

As the next step in the process, immediately put in the churn 100 gallons of hot water and 1 quart of washing powder. Revolve 2 minutes in fast gear with vent open; drain quickly through one or both doors to avoid accumulation of scum in churn. This method is the most economical in time and materials. It produces the very best results. The success of this method, as well as any other method, depends upon the removal of butter before washing is done.

In a damp location leave the churn with doors, bung, and vent open. In a dry or a dusty location close all openings to avoid excessive drying of the churn, which causes butter to stick. To prepare for churning, if the churn is dry, rinse with hot water and cool with a large volume of cold water. The cold water should be revolved in slow gear a long time (at least 30 minutes) to accomplish the purpose. If the churn is not dry, put in a large volume of cold water and cool as described.

The sticking of butter is due to the churn being dry, greasy, or alkali-soaked. The churn may be greasy because it was not properly washed or because it was not sufficiently wetted before churning. A dash of cold water is not sufficient preparation for a dry churn. When butter sticks because the churn is greasy, first wash the churn as described, then make a thin paste of washing powder and water. Put enough of this in the churn to coat it all over by revolving a minute in the fast gear. Leave this in the closed churn over night to "draw" the grease out of the wood. In the morning, rinse with hot water and cool with cold water as directed for dry-churn preparation. This is repeated daily until the grease is removed. It usually requires three days to do this.

Contrary to old rules, it is better not to put lime in the churn. Lime will not do any more than washing powders, such as sodium carbonate. Repeated use of lime coats the wood with a lime scale that causes butter to stick. Sometimes the scale has to be scraped off, which is exceedingly tedious. Soaking with weak hydrochloric acid is more convenient, but must be done cautiously.

Strong alkalis and very hot water should not be used on the outside of the churn. Butter should be removed with warm water (100° to 120°F.) and some form of mild soap. Machine grease should be removed with oily waste or rags.

In keeping floors in good order, the most difficult substance to remove by washing is grease. Hot water, caustic alkali of some sort, and scrubbing with a stiff brush are the most efficient means for removing grease. This treatment does not injure the surface of a cement or tile floor and it does not weaken concrete. In the long run it makes a cleaner floor than does the use of acid.

Acids do not remove dirt directly. They dissolve, or cut the cement and the dirt is removed with the cement. Every time acid is used a layer of cement is removed. In time the smooth surface is gone and a porous. rough surface remains. This absorbs dirt and is harder to clean. Acid attacks more vigorously those spots on the floor where there is less grease. This uneven action soon produces a wavy or bumpy surface. Repeated application of acid makes this worse because the acid settles into the low places, eating them still deeper. Moreover, the acid flows into cracks and holes, eats the concrete and steel, and thus seriously weakens the structure and strength of the floor.

To cleanse an ordinary floor, dissolve about 10 per cent of washing powder in boiling hot water. Pour this in a thin sheet on the floor and immediately scrub with a broom or preferably a brush. The longer this is left on after scrubbing, the better the dirt is "cut." Finish by rinsing off with hot water and sweeping the water down if necessary.

Soap powder or a mixture of washing powder (sodium carbonate) and soap powder may be used on tile or terrazzo floors. It is more expensive of course than sodium carbonate.

A thin paste made of lye and milk of lime is used on cement floors by some butter makers. It is a good, inexpensive cleanser and kills mold but it leaves a white powdery coating on the floor. Lye and soap powder dissolved separately in hot water and then mixed are better. This in the form of paste may be left on over night if the floor is difficult to clean.

The sterilization of woodenware, such as box trucks, butter boxes, tables, and butter printers, presents by far the most difficult problem in a creamery. Such equipment is a frequent cause of air mold in butter. The usual method of cleansing this equipment does not produce enough heat to effect sterilization. The film of grease, often present on such equipment, repels chemical disinfectants. Scrubbing with a brush and hot water containing an alkaline detergent is a necessary preliminary. This is followed by rinsing off with hot water. Then either chemical disinfection or the following method may be applied: Prepare a thin paste of washing powder of the sodium carbonate class, and water. Give the woodenware a thin coating of this with the aid of a brush. Leave on over night and prepare for use by rinsing off with hot water. Instead of this, the woodenware may be sprinkled with salt with the aid of a sieve. This is left on over night. Because molds are very sensitive to alkalis and because alkalis are likely to penetrate a film of grease, the coating with washing powder produces surprising results that sometimes are better than those obtained from chemicals that are strong germicides when grease does not interfere.

Water tanks do not require special methods of cleaning but they are mentioned here because they often are overlooked. The slime that accumulates in water tanks sometimes is the cause of air mold in butter.

For purpose of control 1 cubic centimeter of butter is plated in acid whey agar and incubated. The number of yeasts and milk mold colonies (*Oidium lactis*) that develop thereon are accepted as an index of the thoroughness of cleansing and sterilization of related equipment. The following interpretation of the counts is customary: Total

10 or less, excellent; total 10 to 50, good; total 50 to 100, fair. Inefficient pasteurization or subsequent contamination increases the count. Nevertheless, if the counts are good it is safe to say that the cleaning and sterilization of all the equipment that follow the pasteurizer are equally good.

The condition of woodenware, such as tables, trucks, and the like, may be ascertained by cutting off and plating a thin shaving of wood about one-half the size of a postage stamp (2 square centimeters). This is a very serviceable method for ascertaining the presence of air mold.

Cheese

By J. L. SAMMIS
Associate Professor of Dairy Husbandry
University of Wisconsin

GOOD QUALITY *in cheese-making, more than any other branch of food manufacture, is dependent on extreme cleanliness as well as on freedom from undesirable bacteria. The latter condition necessitates pasteurizing, but lack of economic incentive accounts for the failure of most cheese factories to accept and utilize the latest technical developments in the field. Perhaps the present federal experimentation with ice-well refrigeration on dairy farms will solve the problem in sections where winter temperatures will produce the ice.*

IN no other branch of dairy manufacture is cleanliness more important than in cheese making, and for the excellent reason that the most common causes of bad flavors, faulty textures, and other defects in cheese are well known to be the various kinds of harmful bacteria, yeasts, and molds that get into milk at the farm or factory. In the creamery, condensery, or city milk plant the application of a pasteurizing temperature to kill harmful bacteria is the established practice, but only in a few of the largest American cheese factories is milk pasteurization being practiced at present. The prospect of replacing many small factories with larger ones, and of installing flash pasteurizers generally in these plants, offers a notable opportunity for improvement of sanitary conditions in the cheese industry.

Because the greater part of the milk in the United States made into cheese is not pasteurized the second consideration along this line is of prime importance. In making any kind of cheese whatever, whether from pasteurized milk or not, the first step always is the coagulation of the milk. In the curd so formed 95 per cent or more of the bacteria present in the milk are retained, and so they are present also in the cheese. The whey in the cheese vat contains far less bacteria than the curd. Thus, with the bacteria from 1,000 pounds of milk concentrated in about 100 pounds of cheese, the importance of clean, pure milk for cheese making cannot be overemphasized.

This condition does not occur in butter making, where most of the bacteria in the milk are transferred to the skim milk, with the result that they do not get into the butter or, at the most, are there in smaller numbers than in milk.

In the cheese industry, therefore, every precaution for obtaining and retaining milk in the cleanest possible condition is imperatively necessary—more so than in any other branch of dairy manufactures.

As 3,000 cheese makers may handle the milk from 60,000 farms, with several milkers on each farm, it is evident that the initial problem of keeping milk clean as it comes from the cow is of the greatest practical importance. Cleanliness and quick cooling are the two great lessons that dairy farmers must learn for their own prosperity. After investing the savings of a life time in farms, cattle, and machinery, and using all this invested capital to produce milk for sale through the cheese factory, it is most unfortunate when the farmer, his family, or hired help are not able or willing to take the few extra and necessary precautions to keep milk really clean, and to cool it promptly after it comes from the cow, in order to get the best price for it. The small amount of additional labor at the farm required to make milk utensils really clean instead of only half-washed, is

J. L. Sammis

insignificant indeed compared with all the labor and investment employed in milk production.

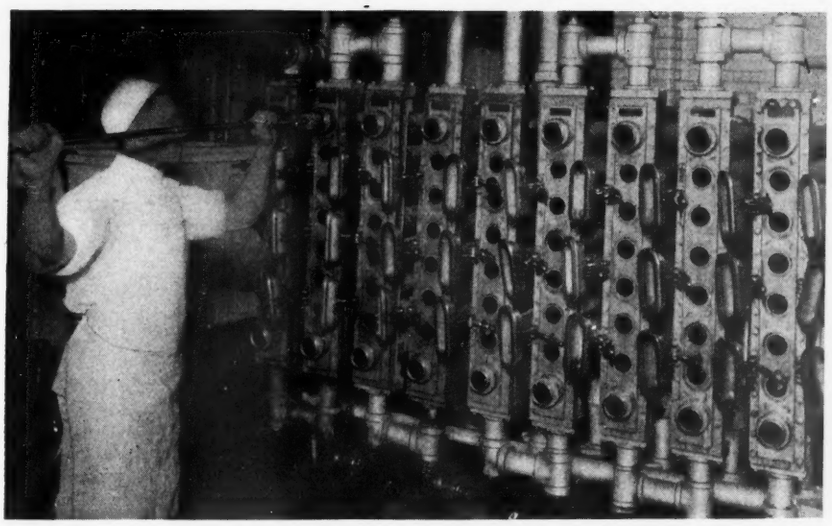
The biggest job in promoting the dairy industry in any new section, such as in the Southern and Western states, is to teach the people the necessity for cleanliness, quick cooling and the proper methods to employ. This is the same lesson that dairymen in Wisconsin, New York and other dairy states have had to learn, and there is no short cut by which it can be avoided. The royal road to successful dairying requires cleanliness at every step of the way, and there is no substitute for cleanliness.

THE progress already made in cream grading among creameries in the United States offers the cheese industry, a much needed lesson, and one that should result in milk grading at every cheese factory. Standards of cleanliness, testing for sediment, temperature, odor, acidity, and other characteristics of milk delivered at the cheese factory should be established and maintained as is already being done by buyers of milk for many city milk supplies, condenseries, and other large users.

A differential in the price paid for milk, such as subtracting 5 or 10 cents per pound of butter fat in milk of inferior cleanliness when received at the cheese factory, would quickly bring about improvement in quality of milk from many farms; moreover there would result better quality cheese, less cut-price cheese, better milk prices at the factory, and greater satisfaction to the cheese consumer, with a consequent increase in demand and price level for cheese in the markets.

To fully accomplish this aim, it is necessary that there be co-operation among the three main groups—milk producers, cheese makers, and cheese distributors—united to recognize and promote better quality in milk, in manufacturing methods, and the curing and sale of cheese. Refusal by any group of cheese buyers to recognize superior cheese quality by establishing and paying a premium for such cheese can be characterized only as a betrayal of the industry's best interests. For what reason should complex and expensive systems of state inspection and branding of cheese be set up, unless the men who do the work—the farmer and the cheese maker—are to receive their proportion of the profits resulting from improvement in cheese quality?

Knowledge of the cleansing power of commercial washing powders, disinfectants, detergents, hot water and elbow grease is abundantly available to every individual dairyman, and it is not the purpose to review here the various recent studies that have treated all phases of the problem of cleanliness in milk handling. Suffice it to say that efficiency in the dairy business pays and pays well. It is, indeed, often necessary to shop around a little if the factory manager is to come upon the cheese buyers that do actually pay premium prices for fine quality cheese. Similarly, care should be taken that there be employed at the factory none but the best, experienced cheese makers, who will



Punching hot milk tubes

conscientiously put good workmanship into every cheese they make. Finally, the really ambitious modern dairy farmer will not be content simply with putting milk into the can, but will be actively interested in making sure that the can is clean and fit for use, and the milk clean and properly cooled.

The lessons of the past are not difficult to interpret. Continued neglect of essential cleanliness will surely lead the cheese industry, or any other industry, into the evils of decreased demand and consumption, with accompanying unprofitable prices and income for the farmer.

Ice Cream

By C. D. DAHLE

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SANITATION in the ice cream plant ordinarily begins with the ingredients used in the making of the mix. Fresh, wholesome milk products are essential to the production of ice cream of a high quality. Some manufacturers today insist on the same quality of raw materials that is demanded by city ordinances for the market milk supply. When this rigid inspection is carried out on the ingredients and proper treatment is given to the processing, a food of high sanitary quality results.

When the milk products are received they are stored at a low temperature—between 35° and 40°F.—until used. If by chance these products are not to be used up in a short time they should be pasteurized. As a matter of fact, practically all the milk products received by our Eastern manufacturers is pasteurized before arriving at the plant. Cream and condensed milk shipped from country plants ordinarily have been pasteurized prior to shipment. As a rule, fluid milk is the only product that has not been previously pasteurized before being received.

The ingredients to be used in a batch are mixed and the entire mixture is pasteurized. This insures safety to the consumer. As most of the milk products have been pasteurized prior to mixing, the pasteurization of the mix is for a large part of the ingredients really a double pasteurization. A temperature of 145°F. for 30 minutes is recognized as proper for efficient pasteurization of the mix. Some are using higher temperatures (170°F.) with excellent results, not only from the standpoint of lower bacterial count but also for other reasons having to do with the viscosity and freezing of the mix.

C. D. Dahle

From the pasteurizer the mix is run through a homogenizer or viscolizer at a pressure in the neighborhood of 2,500 pounds per square inch, usually at the pasteurizing temperature. From the homogenizer the mix passes over a surface cooler where it is cooled to as near 40°F. as possible. From the surface cooler the mix is stored in storage vats or tanks equipped with a cooling medium. The temperature of the mix should be held below 40°F. until the mix is frozen. The process outlined should provide a mix of low bacterial count. The bacterial count will not increase appreciably if the mix is frozen within 24 to 48 hours after aging. Nowadays the aim is to freeze as soon after making as possible. Many are making the mix in the morning and freezing it the same day. This procedure will keep the bacterial count from increasing and will enable the ice cream manufacturer to handle more ice cream mix with less equipment.

No matter how good the raw materials are nor how well the product is processed, dirty or unsanitary equipment can undo the good effects of all other efforts. Fortunately, the majority of the equipment used today in the manufacture of ice cream is of such construction that satisfactory cleansing and sterilization are possible. Steam is available in the modern ice cream plant for pasteurization and therefore is available for sterilizing purposes.

All equipment that comes in contact with the ice cream mix and ice cream is made of materials that are readily cleaned. The vats for pasteurizing are made of tinned copper, glass enamel, pure nickel, or some alloy. Surface coolers are constructed of suitable metals, while the storage vats for the mix are of construction similar to that used for pasteurizing vats. Freezer cylinders usually are constructed of German silver. In addition the pipe lines through which milk, cream or mix flow are made of tinned copper. All surfaces are smooth and readily cleaned and will withstand high temperatures. Efficient sterilization of the equipment then depends on the personnel of the plant.

Some plants are kept in better sanitary condition with less effort than others because of the construction of the buildings and the arrangement of the equipment. The more equipment, sanitary pipelines, and the like, the more difficult will it be to keep them clean. Sanitary pipes for conveying the product should be used where possible, but the arrangement of the plants should be such that as little piping as possible is used, and as few bends, turns, and joints used as possible, because of the difficulty of cleaning them properly. Sanitary pipe lines should be taken down daily, but when a great many pipes are used, with numerous small connections to be cleaned, they are often neglected. If these pipes are not cleaned, brushed, and scalded regularly they become contaminated with bacteria, which will inoculate the newly pasteurized mix with undesirable organisms.

Ice cream pasteurizing vats, coolers, pipe lines and freezers should be washed thoroughly with hot water and a good dairy cleansing powder. About ½ pound of soda ash or ¾ pound tri-sodium phosphate in 50 gallons of water is suitable for washing the equipment mentioned (O. F. Hunziker, "Butter Industry," second edition, p. 59). In addition to the hot water and alkali, a good stiff brush with plenty of muscle behind it is essential to remove every particle of milk adhering to the walls of the equipment. After washing vats, freezers, and the rest in the manner described, the next step is to rinse thoroughly with water at a temperature of 180°F. The equipment will dry out very soon after this treatment.

Pipe lines should be soaked in a trough of warm alkali water as mentioned, then brushed out and rinsed with water at 180°F. Freezers, after draining out the mix, are washed in the same manner except that the dasher is started and the freezer operating in this manner will nearly wash itself. More water may be needed to finish the job on a freezer because the freezer cools down the water used. A mistake often is made in failing to consider this point. The water must not only be around 180°F. but should heat the equipment to near this point to be very effective. The freezer often is neglected because of the difficulty in removing the dashers, which should come out regularly in order to clean out the bearing surfaces and other inaccessible places.

The homogenizer and the viscolizer, possibly are the most difficult machines to clean thoroughly, due to the inaccessibility of some of the moving parts. The valves should be taken out and scrubbed daily, after running hot water through the machines to rinse out as much mix as possible. The other working parts of these machines should be washed as well as possible by passing hot water through the machines while running, and after assembling. After all the equipment is washed it is a good plan to run water at 180°F. through the entire system, starting with the mixing vat and finishing by running over the coolers. Chemical sterilizers are very effective for use in homogenizers and viscolizers.

THERE are a number of chemical sterilizers on the market for use with dairy equipment. These usually are calcium or sodium hypochlorite products, and if used on clean equipment are effective sterilizers. They may be made in the plant or purchased under their chemical names, or under various trade names. These range in strengths from less than 1 per cent to 16 per cent. These hypochlorite sterilizers are used in cold or lukewarm water and are employed generally as a rinse. When using as a rinse or for flushing, between 50 to 100 parts of available chlorine per million are used.

If used as a spray 500 parts of available chlorine per million are used.

After washing all equipment thoroughly, the proper amount of the sodium hypochlorite is placed in the lukewarm water of the pasteurizer and pumped through or over all of the equipment, even to the freezers and hoppers, and then onto the floor and down the sewer. This sterilizer is very efficient as a deodorant around a plant. A stronger solution usually is made for this purpose. It must be remembered, when this product is to be used for sterilizing equipment, that its efficiency is reduced by the presence of organic matter. Therefore, all equipment must be clean before this product is used.

Before using the cleaned equipment the next day, hot water at 180°F. or water treated with hypochlorite should be pumped through the entire system. This will insure a very nearly sterile surface for the new mix.

Condensed, Evaporated and Dried Milk

By F. L. SEYMOUR-JONES
Chemical Engineer
The Borden Company

THERE are three sound reasons for thorough cleaning and sanitation in a milk products plant. Dirty conditions will affect the keeping quality and flavor of the product. There must be no chance of transmitting disease through the product. There is a normal and healthy civilized dislike of dirt.

The flavor of any of the three classes of products under discussion can readily be affected by dirty or sour spots in the equipment through which the milk flows. Such spots are fertile breeding grounds for bacteria and their kin. These can and do affect the keeping quality of sweetened condensed milk. The sugar in this product is a great preservative. Yet even the relatively high concentration present is insufficient to prevent the action of some types of bacteria, molds, and yeasts.

Evaporated milk, of course, is heat sterilized after being sealed in the can, yet if seeded with bacteria beforehand it is more difficult to sterilize and it may not be possible to obtain a successful sterilization without ruining the milk physically. This is particularly true when certain heat-resistant, spore-forming organisms are present in quantity, such as the hay bacillus *(B. subtilis)*. Dried milk keeps well because of its low moisture content, irrespective of its bacterial count. But one must remember that it is used for other food products and if high in bacteria is objectionable in, for example, ice cream, which is watched for bacterial count in the more progressive cities.

Fortunately, these three products have practically a clean bill of health with respect to disease transmission. Every manufacturer watches closely the health of his employees and the sources of the milk. These products have a well-merited rôle in baby feeding. Generally speaking, they are safer in this respect than even high-quality fluid milk.

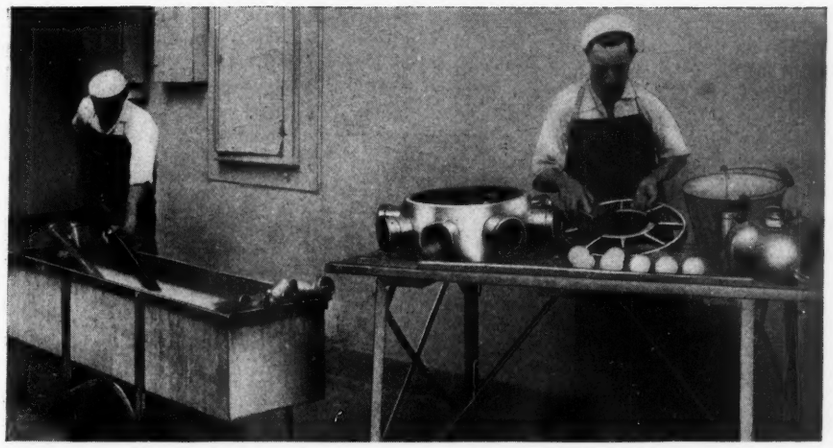
Cleanliness at a milk plant begins outside, at the farm. One of the duties of the fieldman attached to a plant is to educate the farmers to the end that the milk shall arrive at the plant in first-class condition. This implies sanitary condition of the cows and of the stable, as well as of the pails, strainers, and the like utensils used. It especially applies to the cleansing and sterilizing of milking machines. Although washing powder and hot water serve for most dairy farm utensils, the milking machine is chemically sterilized after cleaning, some form of chlorine disinfectant being used.

Inasmuch as the plant expects and requires cleanliness of the farmer, it must display the same quality toward him. The can in which milk is delivered usually are machine washed and sterilized at the plant. This includes cold- and hot-water rinses, in which soda ash or washing compound may be dissolved, steaming to sterilize, and hot air to dry the cans. Not only a clean but also a dry can is necessary to insure that the milk be not seeded with bacteria from the can.

The equipment throughout the plant must be such as to facilitate cleansing. Probably about half the labor hours in a milk plant are spent in cleansing, so the easier a piece of equipment is to clean, the greater is the saving. Hence there is a quite general use of sanitary pipe which is taken apart daily for cleansing. Pumps are simple and disassembled for cleaning after use. Tanks and some types of vacuum pans are provided with manholes so that access to the interior is easy. Some machines, such as homogenizers, separators, and filters, need more attention, as they are difficult to clean satisfactorily. In any event it pays to take them down after use and clean thoroughly. Valves throughout need particular attention. Pockets and dead ends are always dangerous.

Plenty of Hot Water Necessary For Cleansing

A PRIME necessity in the cleansing process is plenty of hot water. Usually, especially in any equipment in which the milk has been heated, a cold water rinse comes first, in order to soften any casein which may have baked on. This is followed by the free use of brushes (steel or fiber) in conjunction with washing compound. Large surfaces of tanks, vacuum pans, and similar equipment need waterproof sandpaper or steel wool. The latter is efficient but



Washing sanitary piping and equipment

objectionable in that it may leave fragments in the equipment. While these probably will be caught in one of the many strainers through which the milk passes before it reaches the can, they may possibly damage valves en route and even land in the final container.

There are many commercial washing powders available. The basis of these usually is caustic soda, soda ash and tri-sodium phosphate. Soap powders are useful in keeping floors and woodwork clean, but are best kept off metal equipment, as they leave a film difficult to rinse off completely. Soda ash sometimes is mixed with bicarbonate, in itself practically inert as a cleanser but serving to make the ash less hard on the hands. Soda ash also is mixed with caustic soda, making it even more corrosive on the hands but useful in machine washing.

Generally speaking, caustic is more effective than soda ash but is harder on not only the hands but also the metals of the equipment. Tri-sodium phosphate is particularly efficient as a casein softener and probably is the most satisfactory of all. Workers at the Massachusetts Agricultural Experiment Station (A. W. Phillips, M. J. Mack and J. H. Frandsen, "Washing Powders for Dairy Use," Tech. Bul. No. 13, May, 1928, Massachusetts Agricultural Experiment Station, Amherst, Mass.), after a study of 36 commercial powders and of their individual constituents, recommended a combination of 60 per cent soda ash and 40 per cent tri-sodium phosphate as the most satisfactory. Such a powder could be made in the plant for about 2½ cents a pound at current market prices.

Other ingredients also are sometimes included in washing powders. Borax has a certain amount of emulsifying and disinfecting power. Sodium zincate, aluminate and chromate serve to protect the metals on which the powder is used. Detergents or scouring powders contain considerable percentages of abrasive together with soap and soda. They are objectional inside equipment as they score it, but are useful on the external parts.

Materials of construction need consideration from the cleanliness angle if they are to be satisfactory. In this country metals have almost entirely replaced wood, except in such cases as cheese vats, churns, and the like. Copper is very largely used where heating is to be done but is objectionable in some respects, being dissolved somewhat by the milk (with effects on flavor and keeping qualities) and attacked by caustic soda and soda ash. Tinned copper is more satisfactory, but here again the washing powders and constant cleansing attack the surface and eventually expose the copper. Glass-lined equipment is very general and satisfactory to clean. Nickel has found some applications but is attacked somewhat by the milk. Encouraging results have been obtained with the "stainless" irons, chrome-nickel iron in particular.

Even if the equipment may be clean to the eye, nose, and touch, it may yet be unclean bacteriologically and a potential source of trouble. Hence it is often advisable to sterilize it before use. The first and most obvious way is the use of steam. This is particularly efficient in closed equipment, such as tanks, where one can be sure that all surfaces reach a sterilizing temperature. Merely shooting a jet of steam at a surface cooler, for example, does more harm than good, as it serves only to raise the surface to a good temperature for bacterial growth.

No definite temperature can be laid down as absolutely safe, as it will vary with the size and nature of the piece of equipment, but normally the nearer to the boiling point the better, taking care that soldered seams are not cracked by unequal expansion. Steaming also should be so arranged that the surfaces are left dry, unless the equipment is to be used immediately. A moist surface is a good breeding ground for bacteria and trouble. Steam connections should be handy to pipes and tanks but should be disconnected when not in use for sterilizing. Otherwise milk will back up the line to the steam valve and be held there warm all day, providing a dead end with every chance for bacterial growth.

The alkali washing powders themselves are good disinfectants, especially if used warm—from 120° to 140° F. However, after use the equipment must be rinsed to avoid introducing alkali into the milk, as this adheres to the surface of the equipment readily and tenaciously. The most satisfactory of the chemical disinfectants and the only ones commonly used are chlorine compounds, hypochlorite in some form or the chloramines. These are very useful on surface equipment, especially large glass tanks. The New York City Board of Health, dealing with milk tank cars, requires the surfaces to be thoroughly sprayed (after washing) with chlorine solution to the end that it will show a strength of at least 100 parts of chlorine per million. The solution is then thoroughly drained off. It should be emphasized that when sterilizing with any chlorine solution the equipment must be thoroughly cleaned first, otherwise the solution rapidly loses its effectiveness.

When using chlorine disinfectants the question of metallic corrosion immediately occurs. While these are very satisfactory on glass surfaces there may be some attack on metals. One combination cleaner-disinfectant on the market combines tri-sodium phosphate with hypochlorite, and this apparently has much less corrosive effect.

Meat Food Products

By L. M. TOLMAN

General Manager,
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IN HANDLING meat food products the question of keeping qualities is all important. The development of the industry has been along the lines of improved methods of handling these perishable products thereby increasing their stability and enabling their distribution over a wide territory.

Meat is a very delicate substance in its fresh condition, easily susceptible to spoilage if not kept under proper temperature conditions and free from contamination. The principal problem of the operating man engaged in the manufacture of meat food products is to determine how to handle his product under proper conditions of temperature, cleanliness, and sanitation to the end that it can be marketed.

Among the most important problems relating to cleanliness and sanitation, my judgment based upon many years

of experience in the industry leads me to say that there are two of outstanding moment: first, the proper construction of machinery, so designed as to permit satisfactory, quick, and complete cleaning and sterilizing, and its proper installation in the factory so that it may be easily accessible and readily cleaned and sterilized; second, the education of the personnel of the industry to a sense of bacteriological cleanliness or, in other words, knowledge of the necessity for sterilization and prevention of bacterial contamination. This second problem is intimately connected with the first; as a matter of fact, they cover the engineering and operating sides of this question of sanitation.

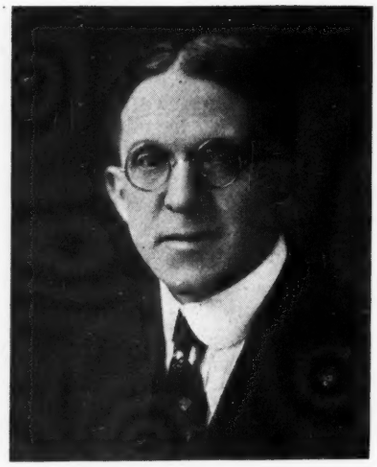
As to the matter of sanitary machinery, important progress has been made in the past few years due to the fact that the industry itself has recognized its necessity. The U. S. Bureau of Animal Industry also has played an important part in the development of sanitary equipment and methods.

There is much progress still to be made by the industry in the matter of training construction engineers to the needs of sanitation, not only in the matter of buildings but in the making of new machinery and its installation in the plant. Too little consideration is given to this really fundamental problem. New machinery should not be installed in the packing house without a preliminary study of the sanitary engineering involved, taking care that installation shall permit the equipment to be handled easily and readily cleaned. Until the construction engineers of the packing industry become thoroughly trained along these lines, this problem will not be properly solved.

In this discussion of cleaning and sanitation of machinery, I have not in mind the ordinary question of apparent cleanliness but, rather, the proposition of keeping the machinery clean from the standpoint of bacterial contamination, which is the real cause of trouble in the future handling of the product. This means that machinery should be so constructed and installed that pockets, corners, and places for the collection of material are removed.

That the last ten years has seen improvement along these lines is due to the fact that the industry realizes the monetary value of improved keeping qualities of its product and that this improvement is tied up very intimately with the sterilization and cleanliness of equipment. We all know that the dairy industry has made remarkable progress in connection with dairy machinery, now making it so that it may be taken apart, and with valves, joints, and other connections so made that they are free from pockets. Often the whole equipment may be completely taken apart and thoroughly sterilized.

One of the recent developments of the work of the Institute of American Meat Packers, under the direction of W. Lee Lewis, has been the sterilization of machinery and equipment by the use of sodium hypochlorite solution. The



L. M. Tolman

results of these studies by Dr. Lewis have shown that much improved keeping qualities can be obtained for these packing-house products by a free use of this solution on walls, floors, table tops, machinery, and the like. In a general way these studies in the use of sodium hypochlorite have followed the experience and work of the dairy industry, members of which have found that the use of sodium hypochlorite solution for cleaning and sterilizing cans, lines, and equipment is of very great value in increasing and keeping qualities of their products and has, further, introduced no objectionable substances into the finished product. This has been one of the recent important advances in sanitation in the meat-packing industry, and without question it has been of great benefit.

The most important development in the meat packing industry, in so far as it relates to keeping qualities of products, will be along the lines of actual sterilization of the equipment to prevent bacterial contamination by the use of non-sterilized equipment, with subsequent spoilage of the food products.

The second problem is that of developing among the operating men in the industry what might be called a bacteriological cleanliness point of view —in other words, an appreciation of the danger of bacterial contamination, knowledge of the injury to the keeping qualities that it brings about, and of how it can be prevented. The bringing about of this point of view probably is a more difficult problem than the question of getting proper machinery installed, because of the difficulty of showing the operating men how bacterial infection takes place.

Through its many years of experience the old brewery industry so thoroughly impressed upon its operating men the danger of bacterial contamination that the personnel of that industry, even down to the laborer, had a very clear idea of how bacterial infection gets into the plant and what damage it does; also, the necessary means of prevention. The personnel of the brewery industry had a very exact conception of what bacterial infection meant and what sterilization meant.

The operating men in the dairy industry have been trained to have as clear a conception of the necessities for sterilization and of how bacteria injures their product. A good many other food industries have to deal with the question of bacterial spoilage and have developed this appreciation of bacteriological danger.

In order to make real progress in the domain of cleanliness and sanitation as it refers to sterilization and prevention of bacteriological contamination, the leaders in the meat-packing industry must emphasize the necessity of training operating and engineering men along these lines. It must be impressed definitely on their minds that this is as important to the industry as is the matter of labor saving and efficiency.

Progress has been made of late years, however, and anyone connected with the industry will recognize a marked change in attitude throughout its personnel. There is still a long way to go before the industry as a whole will build up in the rank and file of the workmen the proper attitude of mind toward this problem.

The leaders in the industry, to a great extent, have the bacteriological point of view as regards cleanliness and sanitation, but it will require a determined effort on the part of these men to develop in the engineering and operating departments the correct point of view—one which will enable the industry to make in the future the progress that it should.

Too LITTLE *consideration has been given in the packing industry to training construction engineers in the fundamental needs of plant and equipment design to permit easy cleaning and sterilizing. The personnel of the industry also needs to develop a consciousness of the meaning of bacteriological cleanliness and its importance to meat food products. In this respect they can well follow the example of the dairy industry and the now-extinct brewing industry, where the lowest laborer had a very exact concept of what bacterial infection and sterilization meant.*

Hypochlorite Curbs Spoilage In Packing Industry

EDITORIAL STAFF

UNDER the guidance of their national organization, the meat packers have of late years conducted extensive experimentation in matters of sanitation. As is related in "Meat Through the Microscope," by C. Robert Moulton, of the Institute of American Meat Packers, sodium hypochlorite has been shown to be the packer's most effective weapon in his warfare against spoilage-causing organisms.

In the chapter on Meat Spoilage it is pointed out that sodium hypochlorite, although a powerful germicide, will not consistently kill all molds if its strength is under 0.4 per cent. This is equivalent to 4,000 parts per million of available chlorine. This non-poisonous source of chlorine, made in the plant by passing a current of electricity through a 5 per cent solution of common salt, or by passing chlorine gas through solutions of alkalis, is regarded by the packers as a supplement to all present methods of cleaning, rather than as a substitute for such cleaning.

A valuable part of the discussion on sodium hypochlorite is the table reproduced herewith:

Where and How to Use Sodium Hypochlorite in the Packing Plant

Where to Use	*Strength*	*How Applied*
Class A—Floors, walls, ceilings, staircases, railings, baseboards, doors, door knobs, window frames and sills; in shipping-rooms, loading docks, offices, hallways, scale houses, stock pens, etc.	0.4% solution	After thoroughly cleaning, spray floors walls, ceilings, etc.; rise afterward where the construction is metal or equipment comes in contact with food products later.
Class B—Edible-rooms: killing floors, cookers, freezers, curing and dry-sale rooms, smoke-meat hanging rooms, sausage packing rooms, sliced-bacon coolers, sausage manufacturing rooms, cutting rooms,oleo and butterine rooms, refrigerator and freight cars.	From 0.4% strength to 100 parts per million (1 gal of 0.4% solution to 40 gal. of water).	After first cleaning in thorough manner, spray walls, ceilings, floors, and equipment. If meat products are present, either remove them before spraying or cover them with canvas; rinse equipment afterward.
Class C—Inedible-rooms: tank house, press rooms, hide rooms.	0.4% solution	Clean thoroughly and spray generously.
Class D—Equipment and utensils: (1) wood construction, (2) metal construction, (3) combination wood and metal construction	0.4% solution	Clean thoroughly; then sterilize by spraying with solution. On metal construction, rinse off with clear water after 10 minutes' exposure. All equipment which comes in contact with meat products must be rinsed off before being used.
Class E—Toilets, urinals, wash basins, drains, sewers, cuspidors, waste cans; dressing rooms, lockers, and locker rooms; elevator pits.	0.4% solution	Spray or add the solution direct as needed. The solution should be rinsed off metal equipment to avoid corrosion.
Class F—Especially adapted to treatment of water in reservoirs, and circulating water condenser systems, and for use in and on drip pans under brine coils.	From 35 to 100 parts per million (1 gal. of 0.4% solution to 40 gal. of water).	Introduce into water reservoir, wells, or cisterns as required, with effective mixing. Do not leave the solution on metal surfaces, as it will corrode.
Class G—Laundry department: (Sodium hypochlorite has long been used as a bleaching solution in commercial and institutional laundries).	0.4% solution (2 or 3 gal. to a washer).	Introduce into second rinse, tepid water
Class H—Poultry feeding and dressing plants.	0.4% solution	Sweep floors and scrub dropping boards and feed troughs, and clean dressing room with hot water; spray with solution.
Class I—Restaurant: rinsing dishes, glasses, silverware; cleansing and deodorizing refrigerators, work tables and floors, dish cloths, mops, etc	Add 1 gal. of 0.4% solution to 65 gal. of cold or warm (not hot) water.	Use after washing in the usual manner as a rinse; if a city ordinance requires steaming, rinse the dishes in the solution just before steaming.

Frozen Fish

By HARDEN F. TAYLOR

Vice-President for Scientific Research, Atlantic Coast Fisheries Company

FOR several reasons, the fish industry presents problems in sanitation of peculiar difficulty. Unlike land animals and poultry, fish are, externally as well as internally, a ready and fertile substratum for bacterial activity because of the naturally wet surface mucus on skin and gills. Their flesh is soft and easily invaded, even slight deterioration, which would not impair the quality of other fresh foods, giving rise to odors in fish that are distinctly disagreeable. In the first instance, the conditions under which fish are caught on vessels and stored in restricted space makes sanitation difficult. Also, fish contain a high percentage of a gluey material, which in the course of manufacture enables bits of fish, scales, and the like while wet to become attached to containers, conveyors, and machinery, and if not removed while still wet they are exceedingly difficult of removal when dry.

So many species of bacteria are found in and on fish that it would be futile to attempt classification or mention of them here. The chromogenic halophiles that infect salt fish; the *Pseudomonas fluorescens* infection of halibut recently described in FOOD INDUSTRIES; the *Bacillus mesentericus vulgaris,* which seems to be universally present not only on the surface but within the tissues of haddock; and the occasional typhoid scares ascribed to oysters, as well as the pink yeast infection of oysters, are all examples of many individual species of micro-organisms that have received the attention of scientific investigators.

In some instances means of combatting infection have been found effective. In the salt fish infection the organism has been traced to a marine origin in solar sea salt. If the premises are thoroughly cleaned with fresh water (which is destructive to the organism),

Photo by Blank & Stoller

Harden F. Taylor

steam hose and antiseptics, and if mined salt or other sterile salt is used, the infection may be avoided. The *Ps. fluorescens* of halibut was traced to infected ice. Unwholesomeness in oysters is prevented by vigilant inspection of grounds for any possibility of sewage pollution. The red yeast infection of oysters also has been traced to marine origin, and is occasionally found in the sea water on the oyster grounds. Spread of this organism is suppressed by thorough cleanliness of utensils and premises.

The instance cited of *B. mesentericus vulgaris* in haddock is mentioned because it has received special research attention, but is only representative of a host of bacteria, always present in fish, which are not pathogenic, so far as we know, but are responsible, collectively, for spoilage. The example mentioned is a spore-forming facultative anaerobe, and produces the ammonia, indol and amines characteristic of spoiled fish. Other organisms produce skatol, hydrogen sulphide, and other ill-smelling compounds.

By way of suppressing growth of these bacteria, many chemicals have been tried, but most of them have had their day in so far as direct sterilization of fish is concerned. At one time boric acid was rather freely used on salt cod, and is still used to some extent in some countries for hard cured fish for export to the tropics. A few years ago sodium hypochlorite was proposed as an antiseptic for fish, and was put on the market under a trade name to be used in the water for ice-making. The hypochlorite ice was used for chilling fish directly. Research at the University of Washington demonstrated that this chemical was ineffective unless used in quantity sufficient to impair the quality of the fish.

Chlorinated water has been and is still being used to some extent to wash fish and fillets of fish for the purpose of partial sterilization. There seems to be occasion for serious doubt that this treatment has any value. Chlorine is an oxidizer, of course, acting directly, and also decomposes water, forming

hydrochloric acid and free oxygen. There is reason for objecting to any increase in the acid content of fish. The large quantity of organic matter present in fish wash water is sufficient alone to consume a vast quantity of oxygen, to say nothing of the fish substance itself. It is a well-known fact that most antiseptics which are effective *in vitro* on free cultures are rarely effective on tissue surface unless the application is severe and in strong concentration, and even then their effectiveness usually is superficial. Haddock flesh is known to be infected deep in the tissues, beyond the reach of chlorinated water. Even when chlorine is used, there always is sufficient infection to produce rapid decomposition in fish when the necessary warmth occurs. As a preservative of fresh fish, refrigeration is our main dependence and not antiseptic chemicals, especially since the latter are only partially effective, if at all.

More recent methods of freezing and packaging fish individually in cellophane, parchment paper, and similar materials represents, perhaps, the greatest single advance in the sanitation of fish. Fish which were formerly shipped in barrels or boxes with ice under highly questionable conditions are now not only protected from handling and insects by impervious wrapping materials but also are preserved by mechanical refrigeration through the entire distribution chain to the consumer's table.

From the aesthetic point of view, many problems of sanitation confront the fish industry. Wet manufacture in a fish plant, at best, is not a particularly pleasing view, with water, scales, slime, blood, trimmings all in evidence, and unavoidably so. The odor of fish to some people is distinctly unpleasant. It is impossible, in the present stage of the art, to avoid all odor in a fish plant where hundreds of thousands of pounds of fish are worked up daily. Byproducts manufacture (fish meal, glue, fish oils, liver oils) are particularly liable to offend and wastes must necessarily be disposed of. Public water commissions may properly object to pollution of natural waters, and residents in a neighborhood may properly object if a neighboring fish plant becomes a nuisance by its odors, even though the fish products coming from the plant are entirely wholesome and sanitary. Even though white tiled walls, white uniformed operators and starched nurses and manicurists may not aid in producing any better or more wholesome fish than would otherwise be produced, any food-producing industry that hopes to command the respect of the public must go out of its way to keep up appearances and avoid offense as well as produce good food.

To overcome the odors of fish, attention must be given constantly to the possible accumulation of bits of fish in out-of-the-way places, and the cleaning of all surfaces that have been in contact with fish while they are still wet. A steam hose merely cooks the albuminous substances and makes them more difficult of removal.

Dripping water from fish when it reaches the ground may penetrate and continue to produce odor for weeks or months. Such seepage may continue through the winter and become offensive only in summer, and then last throughout hot weather. Excavations near a fish plant have been observed to uncover vile-smelling earth several feet down. In such cases it is a question whether to suppress decomposition by application of chloride of lime or to promote decomposition in order to remove the offending organic matter. It has been suggested that the use of some carbohydrate like glucose or malted potato starch would stimulate bacterial growth and remove the offense quickly.

Where fish-meal plants are in operation it has been found that the dust of fish meal may be scattered all around the plant, settling on roofs and grounds, especially where pneumatic conveyors are employed. When this dust becomes moist and warm it may become very offensive. The remedy for this condition is in avoiding any scattering of dust by conveyors or otherwise, dust collectors and air washers being used where necessary. It has been proposed to use electric dust precipitation for this purpose, but, so far as the writer is aware, this principle has not been tried for fish-meal dust. Even when this is done, there are still odors from the fish-meal manufacturing operations. This source of odor has been successfully overcome by means of a ventilator fan and duct of sufficient capacity to produce a negative pressure at all entrances, drawing air into all doors and windows and forcing it out through the stack or flue. Chlorine is admitted to the duct from a liquid chlorine supply in sufficient quantity to be always in slight excess.

For this purpose chlorine is satisfactory. It can be purchased cheaply and controlled with precision. Besides, chlorine may act either by straight oxidation or by the formation of hydrochloric acid with water, the acid in turn combining with and deodorizing the trimethylamine and other basic gases, which are mainly responsible for the odors in fish.

Ozonizers also seem to be effective in combating fish odors. In rooms where a number of employees are at work and ventilation by open windows is necessary, it may not be practicable to draw all odor-laden air out through one duct for deodorizing by chlorine. In this event ozonizers may be installed and the ozonized air distributed through ducts, thereby destroying the odors before they can escape in quantity to the outside, as well as keeping a more wholesome air in the workrooms.

The disposal of trash, such as boxes, barrels, and paper, which has been in contact with fish, may also be a source of odor nuisance. If such trash is burned in the open air, very offensive substances, such as pyridine and acrolein, are produced and disseminated in the air. Incinerators are used for the complete destruction of material of this nature. Where incinerators are employed, they serve a useful purpose not only in the disposal of trash but in disposing of organic waste matter, such as scraps of fish, scales, and débris, which is swept from the floors. These wastes could be disposed of otherwise only through the sewer system, polluting water courses or harbors. Where incinerators are used, the sewage water is screened, the solid refuse being collected and burned.

These means of abating odor and pollution nuisances, except as otherwise indicated above, are in use in fish plants. Collectively they make it possible to carry on fish-product manufacturing operations on a large scale without offense to the neighboring community. They are, taken as an entirety, expensive. They may not be very good positive advertisement, but they serve a most useful purpose in preventing negative or adverse advertisement of a food-producing plant by offensive odors and pollutions.

Canned Foods

By GEORGE A. BURNHAM
Edgett-Burnham Company
Newark, N. Y.

FRUIT and vegetable canning is, of necessity, a wet manufacturing operation, for not only must the fruits and vegetables be thoroughly washed before they are processed but practically every product, except possibly sweet potatoes, is cannned in some form of liquid, which naturally will wet any equipment with which it comes in contact. As a result, there are times when the entire equipment of a canning factory may become wetted with liquids containing organic substances. Maintenance of sanitation and cleanliness involves not only cleanliness but also keeping things as dry as possible, or dry as long as possible. This is because organic substances, when dry, are not decomposed by bacteria, nor do they support bacterial growths. Dampness will facilitate the growth of bacteria, molds or yeasts, with the result that equipment, when not properly cleaned, may become sour and sometimes fuzzy with mold growth.

Failure to clean up properly and regularly involves an economic as well as an aesthetic hazard. The desirability

of scrupulous cleanliness in a factory at all times is too obvious to dwell upon, but there are other reasons for keeping clean, and failure to follow them through involves an economic deficiency of one sort or another. For example, dangerously slippery floors and stairs may very easily be the result of carelessness around a pea canning establishment if spillage of peas upon the floor should occur where they could be walked upon or tracked up stairways. Slippery and sometimes sticky stairways, handrails, floors and platforms may easily occur in catsup plants, particularly in the cooking rooms, where salt and sugar may be occasionally spilled on the floor in small quantities, but which may result in a disagreeable condition that may sometimes be dangerously slippery. Salt usually is hygroscopic and will find plenty of moisture in the steam of the cook room to attract to itself and, with the sugar, make slippery footing.

Smooth concrete floors, in tomato trimming and peeling rooms where refuse may fall on the floor upon which people walk, may constitute a very distinct industrial hazard for workers, particularly those who wear rubber heels, and care in preventing this form of spillage is helpful in avoiding such possibilities of danger.

Equipment that is not thoroughly cleaned every day is very likely to build up an accumulation of highly undesirable débris of one sort or another as the days go by. Corrosion may be a matter of importance. Long apron conveyors may become too sticky to move after standing overnight if the clean-up crew has failed to do its job properly.

Other reasons for keeping the factory in a condition of perfect cleanliness, economic in their nature but bordering on the aesthetic in their importance, are the off-flavors and spoilage of perishable raw material that may occur when it is stored under improper conditions. Although a purely technological problem, we feel justified in believing that it is traceable to improper sanitation and uncleanliness. For example, tomato crates or baskets that have not been kept clean but have been allowed to become sticky with juice, will mold, in which condition they are highly undesirable as carrying or shipping containers for fresh tomatoes. Moldy baskets will re-infect sound fruit and contribute to a more rapid deterioration than would normally occur. Shelled peas transported to canning plants in improperly cleaned lug-boxes are very likely to show mold and to absorb undesirable flavors from the box, which will seriously impair the quality grade of the finished product, if not ruin it.

Prevention of infection of raw material with bacteria is another matter of great importance, particularly if the infection be from spore-forming bacteria that are difficult to destroy by the ordinary processes of sterilization in the cook room. It is a curious fact that it is more difficult to sterilize a food that is heavily infected with bacteria than one which is only mildly infected even though all other conditions are equal. Cleanliness and sanitation afford one means of avoiding the wholesale contamination of raw materials that may lead to imperfect sterilization.

Efficient work cannot be expected of workers in unclean surroundings or in poorly lighted rooms. The worker whose mind is more concerned on keeping his balance while walking over a slippery floor, who lacks a pride in his organization, or who is more concerned in avoiding barking his shins rather than being intent on the job at hand, is not as productive as one who is in a well-ordered establishment working under ideal conditions.

Employees and management should be able to take pride in showing visitors through an establishment. Many canners feel that the money spent in keeping the plant in perfect condition should be charged to advertising rather than to operation.

The best ways of keeping the canning factory clean are rather difficult to describe in so short an article. Properly designed equipment, installed in a factory that has been designed by one who understands how a building and its construction may have an important influence upon the ease of keeping it clean, creates the initial conditions favorable to a clean factory. Much of the equipment used in canning factories is standard no matter where used, though much equipment is fabricated on the job by the personnel of the factory organization. In this group are included such things as cutters, conveyors, tables, benches, floor drains, chutes, piping, holding tanks, and similar structures or equipment that are erected on the job.

Of prime importance is design of equipment that will keep material from getting onto floors, into corners, or under places where it is difficult, if not impossible, to dislodge it. A plant so designed that juices or refuse never fall on the floor is one in which clean-up water is not required with great generosity and is one in which floors are nearly always dry. Therefore they usually are quite clean.

One should not decry the use of water in generous quantities, however, for it is the time-tried instrument of cleanliness. Water has a twofold purpose in the cleaning work of the canning plant: (1) Routine washing of raw materials and (2) the general clean-up at the close of the daily or the half-day period of work. Large quantities of water are used by some plants without good results for the simple reason that sufficient pressure is not behind the water. High-pressure booster pumps usually make for economy of water consumption and, more important, economy of the time of employees in the general clean-up. Whenever possible, pressures of 50 to 60 pounds or more during the clean-up period should be maintained in order to get the work done most cheaply and most effectively.

After a thorough washing with either cold or hot water under high pressure, it is always customary to use the steam hose and blow live steam onto all metal equipment in order to dry it up and prevent rust. The steam hose is of value also for such wooden equipment—conveyors and the like—as happens to be within reach of the steam, for it will dry the wood by the heat that is imparted to it, and will prevent souring where it may have soaked up fruit or vegetable juice and remained damp. Some packers wash their wooden equipment with a solution of benzoate of soda merely to prevent overnight souring. Before operations re-commence, the benzoate should be washed off.

Cleanliness and sanitation are best accomplished by correct design of equipment and structures; by keeping material in proper receptacles and equipment and all waste off the floor; by keeping the place as dry as possible during working hours; by high-pressure cleaning-water supply; by surfaces of equipment that are impervious to liquids; and by eternal vigilance, good light and systematic cleaning and inspection.

It is to the credit of the industry that the cleanliness of the modern fruit and vegetable cannery will bear careful scrutiny.

Tomato Products

By E. PRITCHARD
President, E. Pritchard, Inc.
Bridgeton, N. J.

VERY few products can be manufactured under unsatisfactory conditions without the product itself suffering as a direct result. The off-flavor or rapid spoilage of dairy products, if made under improper conditions, is an extreme example of this generality. Tomato products, on the other hand, possess the peculiarity that frequently they can be made under very bad conditions and yet appear to be good. Usually only a microscopic examination of the products will reveal the telltale evidence, in the form of molds, yeasts, and bacteria, which shows that the raw material was either not in good condition itself or that it was manufactured under improper conditions, or both.

Very few other products carry with them such evidence of their previous condition. It is possible to detect the existence of previous unsanitary conditions in tomato products many years after they occurred, by the mere pres-

ence of the dead bodies of micro-organic life.

Proper cleanliness and sanitation in tomato-products manufacture reach far back into the agriculture of the products and are almost inseparably linked with it. Because of the fact that the tomato is in its best condition for manufacture only a very short period of time, the tendency among growers of tomatoes is to pick them either too green or too ripe; and when they are too ripe the chances of sending partially decayed fruit to the factory are very great.

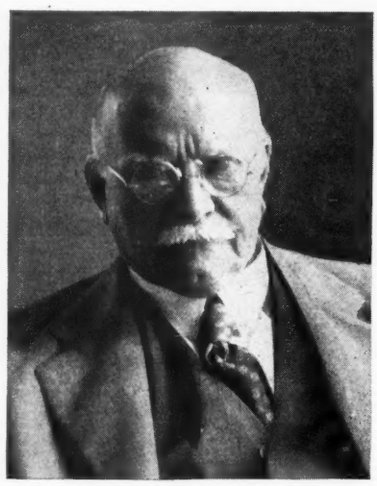
Sanitation in this field, then, begins with getting the right sort of raw material; transporting it to the factory in the proper kind of containers—and in this respect there is nothing quite the equal of the five-eighths bushel basket—and prompt manufacture of the ripe fruit, without permitting it to stand in or near the factory to deteriorate. All of these requirements may be met, and yet moldy tomatoes will be delivered if the baskets are improperly loaded on wagons or trucks. Good loading implies that none of the fruit shall be crushed down by the baskets above, for crushed tomatoes quickly spoil.

The first step of manufacture is sorting the fruit, and if the relation of the business to the agricultural producer is properly handled this phase of the operation will be reduced to a minimum. Purchase of the tomatoes by means of a system, such as the U. S. grades, whereby a grower is adequately compensated for good quality, also simplifies the problem of procuring raw materials in good condition. The ideal method of subsequent handling would be to run the tomatoes over a roller inspection belt and sort them while they are still dry, returning unsuitable fruit to the growers and paying for only the good. The ideal has not yet been attained in many plants, however. The next step, in some parts of the country, is to soak the tomatoes in cold water, which will loosen any mud which may adhere to them, for frequently the period of time involved in passing through the rotary washers is too short to soak off any dry mud that may be there. From the soakers the tomatoes should be elevated automatically into rotary washers and sprayed with water at a pressure as high as possible up to about 40 to 60 pounds per square inch at the nozzle. Spraying at higher pressures serves to tear away any decayed portions of the fruit and render subsequent trimming much more easy.

AFTER washing, the tomatoes pass along some form of inspection belt, and in our experience there is nothing quite the equal of the roller belt, using cast aluminum rollers, which turns the tomatoes over and over as they pass by the inspectors. Other forms of inspection belts are available, but none is quite as efficient as the one just described.

Proper lighting and proper arrangements for the comfort of the workers at this place are highly desirable. Any fruit that is unfit for food is removed at this point and sent to other workers, who either discard it or trim off the undesirable portions. The inspected fruit should now have a final washing, preferably by falling into water, and then should be elevated by a conveyor of such design that the wash waters are not carried along to contaminate the product. The tomatoes are rinsed by sprays above the elevating conveyor, and from this point they go through the manufacturing operations and are converted into tomato pulp, tomato catsup, chili sauce, or soup.

In addition to the necessity of obtaining the raw materials in the proper condition of cleanliness and sanitation, the care of the equipment in the plant is of extreme importance, for the acid condi-



E. Pritchard

tion of the tomatoes and the heavy infection of mold spores that are always present make it perfectly possible for mold growth to contaminate any equipment covered with tomato juice that is idle for only a few hours.

An important obligation rests upon all connected with the factory to wash everything thoroughly. Fortunately, a tomato contains no oily substances, except within the seeds, and hence plenty of cold and hot water under high pressure is the only requirement for a thorough clean-up, unless by unfortunate circumstances mold growths should have started in obscure parts of equipment, such as in the pulper, piping, valves, fittings, or other parts, the removal of which may involve scrubbing and the use of detergents.

Tomato juice coming directly from the pulper is a product that will ferment with amazing rapidity and should not be stored for more than 10 or 15 minutes unless it is sterilized by heat. Fermentation of the tomato juice will not only ruin its flavor but will leave the telltale evidence behind in the shape of untold millions of bacterial or yeast cells which cannot be removed by any method. This imposes the necessity in the plant of having ample equipment at hand with which to work up products as fast as they are started on the course of manufacture, and intelligent control.

Another phase of tomato-products manufacture which deserves very close attention is the nature of the equipment that comes in contact with the products. The organic acids of the tomato dissolve many metals, and although the quantities dissolved may be very small when expressed in percentages, yet the effect is to confer an unpleasant flavor or to result in poor color of the finished goods. Tomato products should not be allowed to come in contact with any metals except the following: tin, bronze or silver, Monel metal, nickel, or one of the highly resistant alloys, such as Allegheny metal, Ascoloy, Nirosta, and the like.

Other materials which may safely come in contact with tomato products are glass and glass linings for tanks and pipes, and cypress for cooking tanks. The practice that prevailed in the past of permitting tomato products to come in contact with bare iron or galvanized iron is not to be countenanced. Wood should be eliminated fron contact with tomato juice on account of its tendency to soak up juice and its inability to be cleaned properly. Such wooden equipment will mold very easily.

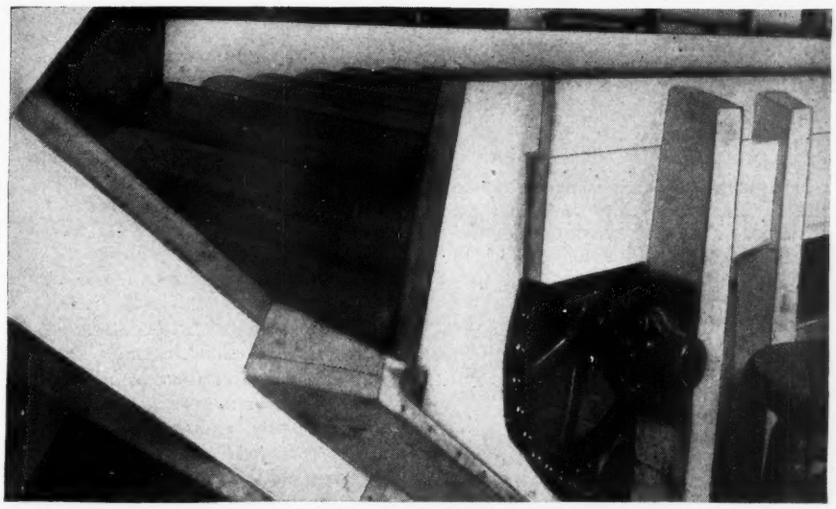
Copper may be used in connection with tomato-products manufacture with safety, provided the copper is always clean and bright—a condition which is rather difficult to attain at the outset. This is because copper tarnishes so readily, and while copper itself is extremely insoluble in tomato juice the tarnish of copper is very readily soluble, as anyone knows who has ever worked in a catsup factory. For that reason copper is to be regarded as a metal which is best kept out of contact with tomato products, except when it is coated with tin or silver.

Tomato-products plants of the future probably will turn more and more to solid nickel kettles, tanks, and piping for handling and cooking equipment. Nickel seems to be a metal that is exceptionally well suited to this service.

ONE of the oldest practices in a tomato-products plant is that of saving spoiled—i.e., soured—tomato pulp to use to wash out the equipment, for nothing seems to clean off the tarnish from copper surfaces like soured material, which, of course, is afterward discarded. The presence of metallic contamination often leads to discoloration of the products or to bitter flavors.

The problem of cleaning cooking coils, where they are used in tomato-products manufacture, is influenced primarily by the dryness of the steam used in them, and this in turn is influenced by proper boiler capacity, steam separators, and traps. Also the drainage of the coils and leaking steam valves are important factors. Where water accumulates in the coils the product cooks on, a fact that accounts for burning always first occurring on the bottoms of coils where it is most difficult to get at for cleaning.

Scrub brushes, wire brushes, and scouring powders may be necessary when burning occurs. Many firms use steel wool for this sort of cleaning. Our experience has shown that copper wool —the so-called "chore-ball"—is superior to steel wool as a coil-cleaning agent.



Discharge end of the roller inspection table showing the cast aluminum rollers

both with respect to effectiveness and because the small bits of it that break off are easily visible to workmen, whereas steel wool is virtually invisible. These small bits of metal may get into valves or pumps and cause trouble. They can be easily flushed into the sewers while the tanks are being cleaned, but bits of steel wool are more likely to be overlooked than copper wool.

Oils and Fats

By M. B. GRAFF
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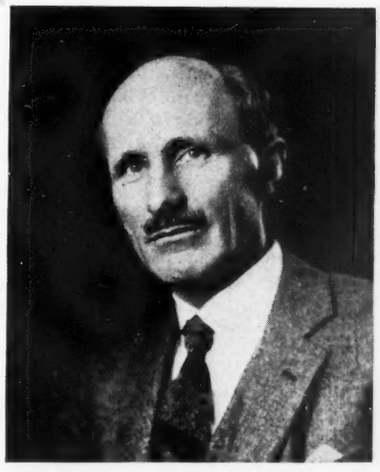
THE products manufactured in the edible oil and fat industries are the refined oils that are themselves consumed as such in cooking and salad dressings, or in products such as shortenings, margarins, and the like, manufactured from these oils. The general requirements of all food products, cleanliness, freedom from impurities and unsanitary contamination, attach to these products naturally.

In addition to these, there are certain special requirements that are of utmost importance. Fats of these types are forced to comply with rigid color, flavor, and odor requirements. They are subject to deterioration and must be produced in such manner as to insure the best keeping qualities. If they are to be respected in keeping with their quality and standards, the packages must be clean and attractive. All these qualities are greatly influenced by the cleanliness and sanitary conditions of the plants in which they are manufactured.

Among the harmful conditions that may be encountered is exposure to air containing dust particles. An unclean room in which a current of air may stir up accumulated dust and dirt will contribute to this contamination. Exposure to air, particularly when hot, has an injurious effect upon the fat, even though not unsanitary. The oil oxidizes and portions cling to tanks, pipes, and other equipment. These oxidized portions, if allowed to remain in contact with the oil or fall into it, promote further and more permanent damage to the oil.



M. B. Graff

In the refining and handling of fats and oils, it is necessary to use steam and water to remove impurities by settling. Moisture, rust, and impurities settled out of oils in handling will cause much injury to the oils if allowed to accumulate and remain in contact with them. These latter two conditions produce incipient rancidity and hydrolysis, which may follow the oil through subsequent stages of the process and cause permanent injury to the finished product in color, flavor, and stability.

Oils and fats are very susceptible to contamination by disagreeable odors. This, again, requires that they be exposed for as short a time as is practicable and that all air coming in contact with them shall be as clean and free from odors as possible.

In order to keep out dust and dirt, the tanks should be kept covered as continuously as circumstances permit. In rooms where filtering and other processes take place, where some exposure is unavoidable, it is good practice to have the windows screened and to keep the rooms thoroughly clean, to the end that no dust particles may be blown about. Good floors, with few sharp corners, easily accessible to a mop with soap and water and a water hose, are very essential.

Tanks and pipes should be emptied frequently and subjected to a good steaming. Steam will remove oil quite readily. Where any considerable oxidation has taken place, it is advisable to boil frequently with a fairly strong caustic alkali. As the oils and gummy material are removed by emulsification, the presence of a small quantity of soap powder may accelerate this process at the beginning. After this, the caustic produces a certain quantity of soap by combining with the oil. After such treatment thorough rinsing is essential and the tanks should be well rubbed out.

All moisture and other settlings that accumulate in the bottoms of tanks of good oil should be pumped off frequently to tanks reserved for the purpose, and wiped out with clean rags or waste. Above all things, rags soaked with oil must not be allowed to lie about the plant, but should be placed in closed metal containers provided for them or promptly destroyed. They are not only unsightly but in the case of some of the oils are subject to spontaneous combustion and may cause serious fires.

Of great importance is the use of plenty of soap and water, with soda, when necessary, and clean rinsing water of good quality to keep all work tables, machines, and floors in packing rooms in the most sanitary condition.

When using glue in sealing packages or wrappers, frequent cleaning is advisable to prevent odors and the development of disagreeable conditions. In this connection an effective measure is the use of warm soap and water.

Provide the best of sanitary conditions for the employees in all departments. Where the packing and handling of the finished product and packages are done, supply the employees with clean, white uniforms and keep them clean. Clean, bright surroundings and clean habits about the plant are probably the best practical assurance of clean products and satised customers.

Margarin

By H. S. MITCHELL
Swift & Company
Chicago

MARGARIN *manufacture, although quite similar to dairying in its essentials, utilizes not only all its usual sanitary precautions but also some of the features of macaroni and gelatin manufacture. Dust-free air, properly conditioned, is considered a requisite, as well as water that is free from objectionable substances or impurities. The aromatic phenol- and cresol-chlorine compounds occasionally found in chlorinated water supplies are as objectionable in margarin manufacture as in the canning industry, where their elimination was first discovered to be of great industrial importance.*

ADVANCE in the manufacturing methods of margarin has been most gratifying since its inception in 1870. So also has been the advance in sanitation and cleanliness. The food industry as a whole has long realized that it serves humanity and that in this service immaculate cleanliness is a vital factor. Everything possible, therefore, has been done to bring about this cleanliness, with the result of greater efficiency, greater pride in the product and, most important of all, a greater safeguard of health, the one invaluable thing in life.

Even before the actual manufacture of the product itself begins, a notable degree of sanitation is obtained by virtue of the fact that all raw materials for margarin production are selected from a quality standpoint of the sort which demands that they be produced under strict sanitary conditions. Animal fats entering into margarin are produced in inspected plants under governmental supervision. All hashing machines, rendering kettles, pipe lines, pumps, and other items of equipment are kept free from impurities. This is brought about by the liberal use of soap and boiling water. Seeding trucks are periodically cleansed with hot water and steam. Filter-press cloths are frequently washed. Each employee is made to realize that everything he does to promote cleanliness promotes quality and that quality is necessary for the success of any product.

The vegetable fats used as raw material in margarin are highly refined by the latest methods developed in this industry. These, of course, include, as in the case of animal fats, adherence to the highest standard of sanitary conditions surrounding their manufacture. Thus, the margarin manufacturer begins his efforts with raw material of a sort calculated to make his product pure and safe for consumption. All ingredients used in the manufacture of margarin are foodstuffs of long standing and recognized as pure and wholesome. It would seem obvious that the combination of these foodstuffs handled as they are in the margarin plant must necessarily be pure and wholesome.

Present day establishment by food manufacturers of visitors' routes throughout the plant serves as a most satisfactory means of impressing upon all buyers of margarin the advanced methods of sanitation followed in its manufacture. They see a plant constructed of face brick, concrete or white tile, which minimizes the labor necessary to keep it spotless. The common instruction of the foreman is to "keep the place so clean that you can eat off the floors." Wherever possible, white is the predominating color in the plant. It seems that white and cleanliness are synonymous, and with white as a background all that is neecssary to maintain this synonymity is a pail, a scrub brush, a can of washing powder or a cake of soap and a man to apply them vigorously. Employees are furnished with white uniforms, maintained at the proper degree of whiteness by the plant laundry. Properly equipped washrooms are available so that the employee may keep immaculate. Manicurists are often available to care for the employee's hands. Advantage is taken of the fact that a white towel will promote more cleanliness than will a health talk, and the clean towel and white wash basin are used as an urge to wash the hands more often.

H. S. Mitchell

It is, of course, well known that margarin is produced by scientific methods. Probably no other part of any food industry requires more care in this respect than the milk room of the margarin factory, where the flavor is developed. It is essential that every vessel used in this room be kept scrupulously clean at all times. Hot water, soap, and elbow grease are applied to every part of this room at frequent intervals. Usually the air is washed as well as cooled to the exact temperature required by the ripening operation, and the condition of the air is followed carefully by periodical exposure of Petri dish cultures, which indicate any bacteria or mold infection. All this attention to sanitation and cleanliness in the milk room is indispensable to the production of a satisfactory margarin, because of the fact that the particular flavor found in margarin results primarily from a selected strain of lactic-acid forming bacteria. This flavor cannot be maintained except under the most favorable conditions for growth of this selected culture. The manufacturer cannot afford to purchase the purest culture and then nullify its action by insanitary conditions in handling.

After the fats are selected and the milk ripened to the desired flavor, the next step is the formation of an emulsion in the churn. This equipment with all lines leading to it is kept thoroughly clean. This means more than simply rinsing with hot water. There are frequent scrubbings with soap and water and occasionally a treatment with a sodium hypochlorite solution. These scrubbings are not merely external in their extent but reach thoroughly every portion of the churn and agitators.

The emulsion as it comes from the churn must next be chilled. This formerly was accomplished by running the product into trucks or tanks containing cold water and then skimming off the crystallized particles of margarin. A later development, which came partially because of sanitary reasons, is the discharge of the emulsion into a slanting chute, where it meets a stream of cold water which chills it and carries it to a truck beneath the chute. Provision is made for the water to drain away. The water used in the water-cooling methods must be of the highest purity. Contamination from it, of course, will be carried through into the finished product. Some time ago the water in Chicago carried at varying intervals a quite pronounced flavor of phenols and cresols which originated at some of the manufacturing plants along the source of the supply. This water, when used in chilling margarin, imparted a flavor which rendered the product unsalable. It became necessary to filter the water through carbon in order to remove the harmless but objectionable flavors. This illustrates the care which must be exercised in watching the water supply. The presence of the phenols and cresols, of course, was indicated immediately by the odor and flavor. Unfortunately, this is not possible with most of the impurities likely to be found. It is necessary, therefore, to be on constant guard against excessive organic matter, high bacteria counts or colon bacilli which might be present in the water used.

Some factories use a chill roll or re-

volving drum, cooled by circulating brine or by direct expansion, and from which the product is scraped by means of adjustable knives. The chill-roll process has greatly simplified the problems of sanitation in the margarin industry. Cleanliness in connection with the water-chilling systems requires constant attention. Furthermore, the large volume of water usually discharged from the receiving trucks to the floor gives an impression of mussiness. All of this is eliminated where it is possible to crystallize the product over a chill roll.

Prevention of mold has necessitated care against mold infection, by spores or otherwise. It is well recognized that slight sources of infection lead to serious trouble. It is quite true that the requisite quantity of salt properly incorporated in margarin will inhibit mold growth. This fact does not, however, permit any relaxation of the constant effort to eliminate this source of possible trouble. Petri dish cultures again prove of value in detecting the presence of excessive quantities of mold in the air. Outside dust is kept out of the building and all parts of the plant are provided with as much sunlight as possible. Care is taken in handling and storing supplies that they do not become sources of mold infection. Cool and dry storage rooms and extreme cleanliness are the most efficient enemies of mold. Where infections actually occur, the use of sodium hypochlorite solution, applied after a thorough cleaning, overcomes the difficulty.

Science has played a very important part in introducing sanitary methods in the margarin industry. When considering science in its relation to industry, one usually calls to mind basic research problems devoted to development of product or to improvement of process. Results so obtained usually are emphasized in support of efforts that may be made to obtain appropriations for the establishment of research laboratories and the extension of scientific endeavor. As a matter of fact, in the margarine industry the science of sanitation has developed along with the other branches of science. As a result, cleanliness and safety have reached so high a standard that the consumer may now safely assume that margarin products are foods of the highest type. This accomplishment must be considered of importance equal to that which has resulted from the application of science to production and product problems.

Mayonnaise

By ALBERT K. EPSTEIN

Epstein, Reynolds & Harris
Consulting Chemists and Engineers,
Chicago

ONE of the greatest problems with which the mayonnaise manufacturer is confronted is that of rancidity, caused largely by the oxidation of the oil with consequent shortening of the keeping quality of the mayonnaise. Manufacturers have learned that careful attention must be paid to the purity of their raw materials. However, proper storage of the raw materials while in the plant and keeping the plant in a sanitary and clean condition contribute greatly to minimizing this type of spoilage.

When a film of oil is exposed to air, it undergoes oxidation and in turn acts as a catalyst, facilitating oxidation of the fresh oil with which it comes in contact. The problem of cleanliness in the mayonnaise plant, therefore, is closely connected with the keeping qualities of the product. The cleaning of the plant must be directed toward the prevention of accumulation of dried oil films on the utensils, machinery, and floors.

Care must be taken that tanks in which oil is stored are made of suitable metal and are clean and not rusty. If the tank is washed out with soda or with any other alkali compound, it must be rinsed thoroughly with water, so as not to leave any of the alkali, as this may form soap with the oil with which it comes in contact, producing an off-flavor in the finished product.

In small plants where there are no large storage tanks, the oil is received in barrels and drums, and from them it is pumped directly into the oil tanks attached to the emulsifiers. Barrels and drums usually contain adhering débris, dirt, molds, and bacteria. It is advisable, therefore, to wipe the surface of these containers with a damp rag soaked in a weak chlorine solution before they are brought into the working room.

Photo by Blank & Stoller

Albert K. Epstein

Mixing bowls and the small oil tanks attached to each emulsifier must be cleaned every day so as not to allow films of oil to be exposed to the air and become oxidized and contaminate subsequent batches. All equipment, such as bowls, oil measuring tanks, knives, spatula, mayonnaise holding tanks and filling machines, must be thoroughly washed after the day's work. In cleaning utensils which contain oil it is necessary to use an alkali washing compound, which will emulsify the oil; then it must be rinsed thoroughly with water so as not to leave a film of soap.

Utensils and machinery that contain mayonnaise should be washed first with ordinary water, as mayonnaise is a dispersion of oil in water. Large quantities of water will dilute the continuous phase sufficiently to dissolve practically all the mayonnaise. If desired, equipment may be rinsed with a weak alkali solution such as soda ash or sodium phosphate or equivalent commercial preparations which are on the market, but in such case they must be finally rinsed with water to eliminate all traces of alkali. The metallic portions of the filling machine should be wiped dry.

Many mayonnaise plants also make cooked salad dressings. In one step of the process, starch is gelantinized with water. All utensils with which the starch paste comes in contact, such as cooking tanks, valves, pipes and holding tanks, should be washed daily and not allowed to stand overnight, as the starch paste is a good medium for mold and yeast and may contaminate subsequent batches and cause fermentation.

Raw materials, such as dry spices required for the day's work, should be kept in closed bins lined with tin. Chopped pickles should be kept covered to prevent the development of vinegar flies. Olives should be kept covered with brine, as otherwise they tend to become moldy.

From a sanitary standpoint, the handling of eggs offers a great problem to the mayonnaise manufacturer. They are the most perishable product, the one most readily susceptible to spoilage, of any of the raw materials used in the plant. When freshly broken eggs are allowed to stand in the plant during working hours, they will undergo sufficient decomposition of a bacteriological and enzyme nature to affect the flavor of the finished product. This is especially true during the spring and summer months, which are among the busiest in the mayonnaise plant.

On the other hand, the ordinary commercial frozen yolks cannot be used advantageously in mayonnaise unless allowed to remain on the floor for long periods of time, so that they will thaw out completely and become sufficiently plastic in nature, lending themselves to emulsification. During the period of thawing and softening, the product undergoes decomposition, and frequently, when the product is completely thawed out ready for use, it is in a highly decomposed state with an

offensive odor, containing many millions of bacteria per gram.

Fortunately, with the growth of the mayonnaise industry, this egg problem has been satisfactorily solved and at present the mayonnaise manufacturer can obtain prepared egg products which are specially processed for mayonnaise use in such a manner that when they the brought into the plant they do not have to be allowed to stand any length of time before they are ready for use. Furthermore, these processed commercial egg products can remain in the plant for several days without suffering any bacteriological deterioration whatsoever. The use of such prepared egg products increases the cleanliness and the sanitary condition of the plant, as there are no shells to take care of nor any egg cans with putrefied material.

If a homogenizer or viscolizer is used, it may be cleaned as follows: First, a sufficient amount of water is pumped through to eliminate practically all the mayonnaise adhering to the valves and pistons, then a weak alkali cleansing solution is pumped through, followed with clean water to eliminate traces of residual alkali or soap. It is advisable to unscrew the top and clean the valves thoroughly and wipe them dry each day after operations are completed.

If a chlorine solution is used to rinse utensils or machinery, care must be taken that it be alkaline, as otherwise it will excessively corrode the metallic parts of the equipment. Even if an alkaline chlorine solution is used, it must be thoroughly rinsed out before the equipment is used again, as traces of chlorine, when in contact with a mayonnaise emulsion, will have a catalytic effect upon the oil oxidation.

MAINTAINING sanitation in the manufacture of mayonnaise products involves the same care of the oils and cleanliness of equipment that is necessary in the edible-oil refinery itself, for otherwise accelerated oxidation will occur. The problems involved in proper handling of frozen eggs are similar to those involved in the egg-noodle factory, although somewhat more critical. Bottle washing is important here, as it is in dairy and beverage manufacture.

It is advisable to wash and sterilize the glass containers, for this is the best means for eliminating dust, dirt and organisms with which the glass becomes contaminated during shipping and storage. Cleansing glassware by blowing air into it is not satisfactory. The caps and liners should be kept in covered bins at all times and not exposed to dirt and dust.

Soap and water should be used liberally on equipment, tables and floors, and nothing is more conducive to the generous use of water than a tile, brick, or concrete floor with sanitary drain. There is a natural aversion among most laborers to "spilling" water on a wood floor; no amount of preaching avails; but if the floor be watertight, it is comparatively easy to get the help to employ a water hose without stint.

Wheat Flour

By M. M. FREDEL

General Superintendent
Hecker-Jones-Jewell Milling Company
New York City

KEEPING the mill clean has an importance far greater than would be apparent to the average sanitarian, to the lay observer, or to the manufacturer in other lines who is not familiar with flour milling. The problem of cleanliness in the flour mill involves not only the usual procedure necessary to keep a manufacturing plant clean but also is involved the matter of insect infestation—the greatest problem that the flour miller faces, and one which will occur in any mill unless precautions are taken at all times to combat the pest.

The chief insect pest of the flour mill today is the Mediterranean flour moth, whereas 30 or 40 years ago the insect was almost unknown in America. At that time the flour weevil, which still exists in the flour mill and which is especially prevalent in grain elevators, was the commonest form of insect infestation. The flour moth is commonly called "the scourge of the flour mill." The Mediterranean moth measures less than an inch across the expanded wings and is seldom seen flying about.

By nature the moth is quiet, almost sluggish. It is easily caught by hand, and for this reason it seems to have little sense of sight or of fear. The small, grayish white eggs are laid in cracks and in accumulations of flour down through the elevator legs, throughout the spouts, around dust collectors, bolters, and purifiers. At a temperature of 90° F. these tiny eggs will hatch in 3 days. The little caterpillar emerging from the egg at once begins to spin a web wherever he travels and feeds. It is his web-spinning that renders this moth such a nuisance.

In 40 days these caterpillars are full grown and leave their cocoons. The pupa stage lasts from 8 to 12 days. It is a known fact that the insect passes through its life cycle in 9 weeks. The masses of web made by these caterpillars will clog machinery and spouts, thereby constituting a distinct fire hazard. The problem of cleanliness, therefore, involves not only keeping clean and removing as much dust as possible but also getting rid of this insect infestation which interferes with successful flour-mill operation.

The following suggestions are made, not only because infested flour will be returned by customers but because the action and behavior of the insect in the mill actually impede its efficient operation. Probably the largest factor in successful mill cleaning is the type of floor construction. Wherever ordinary hard or soft wood floor is found, the cracks, which are inevitable, will afford ample opportunities for the breeding places of both types of insects. These cracks are spots from which it is practically impossible to dislodge them by any mechanical means. The only way to rid the mill of such insects is to fumigate.

In the writer's experience, nothing is quite so effective as the hydrocyanic fumigation, or any other gas equally destructive. It is not necessary to dwell upon the method of handling gas fumigation in this article, but its results are most beneficial from the operating standpoint as well as from that of providing a finished product that is satisfactory to the customer; for this method of fumigation will absolutely destroy all insect life that depends on oxygen for the continuance of its existence.

Although a concrete floor is not as comfortable to walk upon as a wooden floor, nor as easy to install machinery upon or to cut through for spouts or other openings, it is far superior to the wooden floor. The concrete floor presents an impervious surface and, theoretically at least, has no cracks in which insects can find a home. If all flour mills were equipped with concrete floors the problem of keeping down the pests of a mill would be considerably advanced toward a more successful solution.

Another problem that the flour miller faces is the growth of insects in the spouts. A large mill will contain many hundreds of these spouts, frequently traversing great distances. When the spouts are constructed of wood they present the same facility for insect life that is found in a wooden floor. Anyone constructing a new mill can go far toward avoiding future trouble of this sort by utilizing nothing but metal spouts. Even when metal spouts are employed and when concrete floors exist throughout the plant the problem is still far from solution, for the insects will gather and grow on the flour dust that lodges on walks and on ceilings around windows and doors, or in any dust accumulations in other locations.

No means has yet been discovered that is entirely successful in cleaning up the dust around a flour mill. The push broom provides the time-honored method of sweeping, and there also is a method of employing a vacuum cleaner to gather up the flour and dust. Unfortunately, however, no vacuum

system for flour mills has been perfected. There are certain features of mill construction which should be utilized and certain practices which must be carried out, if the mill is to be successfully fumigated at the regularly recurring periods when the necessity for getting rid of the insects arises.

It is a fact well known to all who have had experience with cyanide fumigation that the gas penetrates only about 3 or 4 inches into a solid mass of flour during the course of the usual mill-fumigating period, which usually is 24 hours. Therefore, it is important that all accumulations of flour at any place in the mill be removed before the fumigation is carried out; otherwise, those accumulations which are more than 3 or 4 inches deep will become breeding places and sources of further infestation, which eventually can be spread all over the mill and bring about, as a result, a condition equally as bad as, if not worse than, it was before the fumigation began.

Places of such nature that deserve closer attention are, particularly, the bottoms of the elevator boots. These should be thoroughly cleaned before fumigating. It is also particularly advisable to clean out these boots every 4 weeks to keep down infestation. These quiet places provide breeding quarters for both moth and weevil. Another place is the bottom of the spiral conveyors, which always have a certain quantity of flour in them. As the conveyors are constructed today, there is no really effective method of cleaning them except by blowing with compressed air. This method is most

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unsatisfactory, because it is so disagreeable to the operator and also because it scatters the webbing and the dust into all parts of the room. Anyone constructing a mill, or installing new conveyors, should figure on some method whereby the bottoms of all conveyors can be dropped for this cleaning-out process preparatory to fumigation.

In mills where proper vigilance is exercised the flour shipped out will usually keep in good condition with respect to insects for periods of several months, provided the various persons through whose hands the flour is passed will store it under suitable conditions to prevent re-infestations.

Commercial Bread

By H. E. TURLEY
Stein-Hall Manufacturing Company
Chicago

DESPITE the fact that our good friend "the housewife" seems always ready to point an accusing finger at the baker, and on the slightest pretext, it still is true that he is not always to blame for the appearance of mold on bread, for it is well known that a loaf of sterile bread will become moldy if placed in an insanitary bread box. And yet the baker is not entirely blameless for the appearance of mold on bakery goods.

All who bake bread commercially should become more fully acquainted with the nature of mold infection and with up-to-date methods of sanitation, for molds and harmful bacteria cause the loss of several million dollars a year. Also, the charges of the housewife often are of a very serious nature, such as, "One of your girls must have spilled face powder in the dough," and "Your bread has poisoned my entire family." The baker, not knowing the nature of the various molds, is often much perplexed by such accusations by customers.

When the word microbe is mentioned, one usually associates the word with a "bug" of the sort that causes a great deal of woe and distress to people generally, but all micro-organisms are not black sheep. In fact, most of them are beneficial to mankind.

A mold is a plant of the fungus group that will grow upon or spoil prepared food material. Mold growths consist of masses of long, slender, vegetative threads. Stalks arise from these threads, on which are borne spores. Mold spores are the seeds of the mold plant. They are very minute, about one-fifteenth thousandth of an inch in diameter. Realizing how easy it is for a dandelion seed to be carried in the air currents, it is obvious that it would be even easier for a mold spore to be carried on dust particles in the air. A patch of mold no larger than a dime can produce many thousands of spores. Mold spores are present in the air, in particles of dust on the walls, and, in fact abound practically everywhere.

For growth molds like warmth, food material, moisture, dark places, and as a rule, acid conditions. A loaf of bread that is wrapped too warm will "sweat," whereupon a lurking mold spore will be happy in its new home, well supplied with surface moisture. A loaf of bread produced under sanitary conditions may become moldy if placed in a dirty showcase or in a damp, filthy bread box in the housewife's pantry. Mold spores thrive upon pieces of old dough or other food material allowed to accumulate in corners or in waste pails.

Of the many kinds of mold that can attack bakery goods there are only two capable of producing harmful results when eaten, namely *Rhizopus nigricans* ("whisker mold") and *Aspergillus niger* (black mold). These molds will produce illness if eaten in quantity. But what person is going to continue eating a piece of bread if it has a musty or sour taste? Fortunately, these molds have their warning signals, in that they produce a musty flavor. Bread that has become moldy by a veritable host of molds has been eaten experimentally, and with no harmful results. The orange mold of bread is even used by the natives of Java to mold the earth-nut, which they consider a delicacy.

Regardless of the harmless nature of most molds, their mere presence does not convince the public that the loaf was produced in a sanitary bakery. The housewife is not yet ready to accept a patch of mold as a beautiful decoration or as a condiment to tickle her palate. Thousands of people have stopped buying one particular baker's bread because it usually was moldy. Many bakers have been told by customers that they became ill by eating their bread and have received unfavorable publicity by the public in general.

In extremely rare instances, red bacterial spots appear on the outside of the loaf, the spots sometimes occuring in streaks. From its appearance, the disease became known as bleeding bread, wunderblut, and blood rain. In the early centuries people believed to be responsible for this condition were even burned at the stake, having been accused of bewitching the ceremonial bread. The disease is caused by a short rod bacterium and appears only in unusually hot, damp weather. Scientists agree that the organism is harmless to the human body.

"Rope" is another bread disease produced by the action of an organism, known as *Bacillus mesentericus vulgatus*. The disease gets its name from the fact that a diseased portion of the loaf becomes stringy and can be pulled out in long threads. Its presence can be detected in its early development by an odor resembling overripe cantaloupes. The crumb then becomes darkened to a yellowish gray and finally a muddy brown color.

The rope organism is a typical soil bacillus and also is associated with filth. The source of rope also may be found in the flour, for the bacteria are found in

the crease of the wheat kernel and in the bran coatings. This organism does not like acid conditions for its development. Normal dough fermentation is of the acid sort, so rope occurs only in cases of acute infection and in cases of abnormal fermentation.

The rope bacillus is able to withstand the baking temperature, due to its ability to produce within itself a protective body, known as a spore. This spore is covered with a gelatinous-like coating, which acts as an insulator against the penetration of heat. Ropy bread has never been known to cause any ill effects when eaten, even in large quantity.

Fortunately, rope can be very easily controlled by using a quart of 90-grain vinegar to every barrel of total flour in the dough, and 3 pints in extreme cases. Certain sanitary precautions should be taken, such as washing walls, floors, and ceilings; and washing all utensils with hot vinegar solution. Returned stale loaves should not be allowed to accumulate in the bakery.

Molds, as a rule, prefer acid conditions of growth, and the rope bacillus alkaline conditions, so from this method of control the baker is in a measure between the devil and the deep blue sea. The method of control chiefly depends upon certain definite sanitary procedures.

Where any disease organism has found a spot where it can breed for a sufficiently long period, which, in point of actual time under favorable conditions may be a very few hours, there probably will be found agglomerations which will not be killed by a fluid passing over them lightly. They will have to be disturbed or disintegrated by physical action. This calls for a liberal use of the scrubbing brush.

For cleaning floors of the type commonly found in bakeries, the most satisfactory cleansing solution consists of a large proportion of the common soda compounds, together with a small quantity of soap in hot water. A prepared soap powder also is highly satisfactory for this work.

IN ADDITION to the use of common cleansing powders, a disinfectant spray or wash should be used at least once a week, especially in the oven room and the wrapping room. Especially should this practice be followed during the summer. For this purpose should be used any of the prepared sodium hypochlorite preparations, care being exercised in obtaining a brand that contains a relatively large quantity of available chlorine. For disinfecting walls, floors, machinery, and bread racks the preparation should be diluted with water so that 0.5 per cent of chlorine is available. For disinfecting drains and sewers use the preparation twice this strength. Sodium hypochlorite preparations may be used either as washes or as sprays.

In addition to the common methods of sanitary practice, there are certain other definite procedures to follow in order to lessen the appearance of bread diseases. Wrapping paper should be stored in a cool, dry place. If possible, the wrapping machines should be placed in a

H. E. Turley

room flooded with sunlight. If the baker follows the bad practice of accepting returned "stales" they should not be brought near the wrapping room. Mold infection often comes through the medium of dusting flour blowing into the wrapping room and from dust blown in from the street. Bread should be thoroughly cooled before it is wrapped. The cooling time varies with the temperature of the cooling room. After a loaf feels cool to the cheek, that particular lot of bread should be cooled half an hour longer.

A baked loaf of bread is sterile as far as mold is concerned. Infection takes place after the bread has left the oven. During the last 10 minutes of baking the center of a loaf of bread reaches an approximate temperature of 210° F., a temperature sufficient to kill the spores of bread mold.

Bread diseases exact a very heavy yearly toll from the monetary returns of the baking industry. It is sincerely hoped that the foregoing information will assist in giving bakers a better understanding of the nature of mold infection and methods for its prevention.

Biscuits and Crackers

By HARRY STINER
National Biscuit Company

ONE of the prime necessities in the production of crackers and closely allied products is sanitation. The very care with which their delicate flavors are compounded, and the invariable accuracy accompanying the assembling of the materials of which they are composed, clearly emphasizes both the wisdom and the necessity of eliminating such extraneous influences as insanitation would introduce. No

Harry Stiner

acceptable formula for sanitation, universal in its application, is possible. The great variety of organisms instrumental to, and inseparably connected with, decomposition, putrefaction, and disease, together with the host of individual opinions as to what constitutes the condition, generally results in the creation by each producer of his own standard of excellence. The manufacture of crackers, like all other foodstuffs, is attacked on all sides by these enemies. They come to the factory in raw materials, on the containers, in the water, and even in the air.

Nearly all the articles entering into the construction of crackers are favorite growing mediums for molds, yeasts, and several bacteria, especially when the moisture and temperature are right. Certain of these organisms are as essential to the preparation of our foods, and to our digestion and health, as others are detrimental. The microorganisms found in foods are often divided into three rather broad groups: those that bring about desirable digestion or fermentation during the preparation of the materials; those that produce undesirable fermentation or decay; and those that tend to produce disease—pathogenic organisms.

In the making of crackers, yeasts are the principal organisms employed; however, many of the materials used in their preparation have been developed previously by bacteria and molds. These last are controlled during the process of manufacture and checked at the proper time. It is the decay-producing bacteria and molds, as well as the pathogenic forms, that must be guarded against; and while baking generally destroys all life in crackers, they readily become reinfected when proper attention is not given to sanitation in the plant.

Crackers may become contaminated in many ways during their comparatively short trip from the oven to the package. The relatively high heat of baking gives to the product an abnormal capacity for moisture. This mois-

TIGHT FLOORS *are as desirable in a cracker bakery as in a flour mill or a bake shop. Also, the steam hose finds as good use here as in the canning and dairy industries for cleaning, drying, and sterilizing. Fumigation as a means of pest control in a cracker factory is as essential as in milling and cereal food manufacture.*

ture is mostly discharged during the cooling, but if the crackers are placed in piles, or in any way so arranged as not to permit free circulation of air, it will collect on their unexposed surfaces, making them wet and soggy when cool. Such material when placed in packages retains its moisture, and is almost certain to develop mold; or if permitted to lie in the piles until dry, mold spores generally will have had sufficient time to send their mycelium through the outer crust, where enough moisture will be found to continue growth.

TO OPERATE a factory without the presence of undesirable organisms is not practicable; however, everything that is done to reduce their prevalence, such as sterilizing the utensils, the machinery, the floor, and the walls, minimizes the chances of their detrimental influence. Their sources are legion, likewise are their foods. The dust from emptying the flours in the containers drifts about to settle in cracks and crevices. Small particles of all the materials will, from time to time, find their way to the floors, thence into cracks, under machinery bases, and the like. With these particles go scores of organisms that are floating about on currents of air. Many will come to rest upon such objects as conveyors, utensils, and cooling pans, where conditions may be unfavorable to their growth at the time, but they will furnish one of the most potential sources of contamination to the moist foodstuffs later.

A normal water supply contains some organisms, but when left around in open vessels, or used for rinsing wipe cloths, utensils, or hands, it soon becomes heavily infected. Wipe cloths —that is, rags or towels used to wipe baking pans, cooling boards, conveyors and the like—are, among modern factories of today, only a memory. Steam under pressure is frequently used in their stead, and it not only cleans the equipment more thoroughly but fully sterilizes each part. Molds and bacteria cannot develop on dry, clean utensils, therefore steam is superior to water also, in that any moisture quickly disappears, due to its high evaporating heat.

The flours, meals, sugars—in fact, nearly all ingredients used in crackers —are favorite foods for insects and rodents. These pests constantly carry thousands of micro-organisms about on their bodies, which in turn are brushed off as they move around; and when they are not eliminated, sanitation must suffer.

Sanitation around a cracker factory can almost be specified by the dual declaration: cleanliness and pest control. Due to their odors or flavors, many materials commonly employed for these purposes are prohibited; but such substances as formalin, carbon bisulphide, and sulphur dioxide, as fumigants; and hot air, steam, hot water, soaps, washing powders, and sodas as cleansers, are not only easily obtained but with the addition of the proper inclination and intelligence will answer every purpose.

Macaroni Products

By GLENN G. HOSKINS
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Foulds Milling Company
Libertyville, Ill.

LIKE other food products, macaroni has attendant upon its processing the problems of sanitation and cleanliness that are common to all food factories, plus certain specific problems not readily recognized by the casual observer. Macaroni is the term usually applied to the whole line of alimentary

Glenn G. Hoskins

pastes. It is made by mixing flour with a little water, kneading into a stiff dough, pressing through dies and drying. The process sounds simple, but in each stage complexities arise which give foundation to the old-world theory that the secret of macaroni manufacture is a heritage to be handed down from father to son.

The more technical problems of cleanliness and sanitation include the fire hazards that occur if quantities of dust are allowed to accumulate; weevil infection, which is common to all cereal products; souring of dough in the press room; molding of the product in the drying rooms; cleanliness of employees throughout the factory; and the disorder which seemingly develops almost instantaneously upon any lessening in the interest of the employees and supervisors in the appearance of the plant.

The hazard from dust explosion in the macaroni factory is not as great as that which attends flour milling. So-called macaroni flour is really not a flour at all, but is coarsely granular like granulated sugar, being known as semolina or farina. Even so, a certain quantity of flour dust is bound to accumulate. This is easily taken care of by regular cleaning of the floor and walls and the ready circulation of air throughout the flour storage room.

Weevil infection is more of a problem. Semolina granules are as large as weevil eggs and consequently weevil eggs that have been deposited in the wheat kernel are not always broken in the process of milling. Great care must be exercised to keep the "bugs" from developing. Wherever flour lodges in cracks or corners they will hatch in a few days under the conditions of heat and high humidity existing in the plant.

Some macaroni manufacturers find it necessary to fumigate the plant with cyanide gas periodically, but we have found that the best remedy is to fill all cracks in the flour room with a bitumastic compound; make all corners rounded; paint the walls so that there are no crevices in which flour dust can lodge; see that all conveyor spouts are straight and that sifting machinery has no pockets in which dust can accumulate. Flour sacks are run through a vacuum cleaner as soon as dumped, then bundled and stored outside the flour room. In addition, we have an arrangement with the mills by which the grain sacks are fumigated before refilling. Furthermore we insist upon regular cleaning of the flour room and all other parts of the factory.

All cereals are subject to infection from outside, and in recognition of this every effort is made to produce a perfectly tight package. However, box cars that have been used for hauling wheat and bulk cereal are usually found to be weevil-infected, and many cereal warehouses are overrun with weevils. Therefore, if goods are returned to us for any reason, they are stored in a small warehouse, not connected with the main factory, where they are inspected and if any sign of infection is present they are either burned or sold for animal feed.

If insect eggs are present in the

semolina when received from the mill they are not allowed to develop, because the semolina is seldom carried in storage more than ten days, and as soon as the dough is subjected to pressure in the hydraulic presses the eggs are probably either broken or rendered sterile. The pressure used to force the dough through the dies to form the macaroni exceeds 3,000 pounds per square inch.

The addition of water to the semolina to make the macaroni dough creates a condition that is favorable to bacterial growth, and may cause fermentation and souring of the dough. The mixing, kneading, and pressing operations must therefore be carried on at a speed that will prevent the wet dough from souring during the process. Particles of dough that lodge in the machines, or a whole batch that might have to stand for a period of time before being pressed into shape, are liable to ferment. When any portion of this fermented dough comes in contact with a fresh batch it acts as a starter and tends to contaminate the whole mass and, unless extreme care is exercised to keep all machines clean and to move the dough rapidly through the press room, there results an evil smelling, useless mass of sour dough.

Souring is not the only faulty condition that may arise from the lodgement of small bits of dough in conveyors and various other items of equipment. Very small dough particles will dry quickly, becoming hard before they sour. It is frequently the case that trimmings, which are automatically returned to the mixers for incorporation in the next batch, lodge in the conveyor and become dry. If, after drying, these particles are allowed to be carried along with the batch of fresh dough they will get into the holes in the die, thereby causing imperfect strands of macaroni. This particular problem of cleanliness involves the design of conveyors, belts, mixers, kneaders and presses to the end that there may be no possibility of particles of dough adhering anywhere along the line of travel.

The macaroni manufacturer's greatest problem in sanitation and cleanliness is concerned with molding. The production man is running a race at all times with molds in his drying rooms. The moist dough, pressed into strands and hung on racks in the drying rooms, finds there a warm high-humidity atmosphere that is conducive to mold growth. Slow drying is far better than fast for the physical qualities of alimentary pastes, but, unfortunately, slow drying is liable to permit molding, with a resultant product of sickly, greenish hue and musty taste. On the other hand, extremely rapid drying, although preventing the molds from getting the slightest chance to grow, sets up mechanical stresses in the strands that make the product extremely brittle and cause it to "check," or craze. Either result will depreciate the merchantable value of the product.

The operation of drying all macaroni products, then, is of necessity a compromise between the rate of growth of molds and the best speed of drying the product. Mold spores must come from somewhere, and our way of cutting down the tendency to mold is to reduce to a minimum the sources of supply.

Many tons of water are absorbed every 24 hours by the air that circulates through our plant. Under certain conditions a portion of this water will soak into the walls, ceiling, floors and drying racks in the dry rooms. Soon an airborne mold spore will find lodgement in a damp spot, rapidly developing millions of other spores. The mold growth usually is on the surface of the walls and, as soon as these walls dry out, the microscopic, dust-like mold spores are ready to fly into the air and lodge on any moist substance, such as the freshly made macaroni, which is more favorable to their propagation than the wall on which the molds were originally developed but which now has dried out.

We have tried many ways of overcoming this trouble and have found that there is nothing so effective as a coat of white enamel paint every 3 or 4 months. It is obvious that no factory needs painting that often in order to keep it white, but by this method we have practically eliminated the development of mold in our manufacturing process. We use a spray paint-gun, and with it a dry room, 20x40 feet, can be given a coat of paint in a couple of hours. The paint keeps the moisture from soaking into the plaster or wood walls of the drying room, with the result that the mold spores have no breeding place.

Apparently mold spores exist to some extent in all flour. Products made from some flours tend to mold more rapidly than others under similar circumstances, but we have established a drying schedule that has enabled us to eliminate the development of these mold spores in the flour. This drying schedule is based on the control of temperature and humidity and is so regulated that it is not allowed to vary more than one-half of a degree from a predetermined schedule over a period of 48 hours. Any marked variation from this schedule in the early stages of drying will permit a white mold to grow, and if it is allowed to continue to develop it will turn into a green appearing mold, due to the formation of green spores, and thus complete the ruin of the product.

Originally we had to contend with considerable dust and coal smoke, but we have been able to practically eliminate dust coming from outside the plant by installing automatic stokers, which eliminate the smoke nuisance; seeding all surrounding plots of ground with clover and blue grass, and paving adjacent streets. All the air used in drying is run through an air washer, primarily to regulate the humidity, but with the result that all dust is removed from the air before it is circulated through the plant.

There is, of course, the problem of the cleanliness of the workers themselves, because wherever "long goods" are produced it is necessary that part of the material be handled by human hands, both in the press room and in the packing room. This phase of the problem is taken care of by providing all workers with uniforms and insisting that they be kept clean, by more than adequate toilet and washroom facilities, and by medical inspection to insure personal sanitation.

A motto reading "Cleanliness First" is painted on the walls around our plant, and we have tried to establish the habit of cleanliness in our supervisors and employees. Development of this attitude of mind is very largely the result of rigid discipline, but we have found that the various departments take pride in being able to show an orderly, perfectly clean workroom to the visitors who are constantly going through our plant.

Refined Sugar

By LOUIS LANG
Edgewater Refinery
National Sugar Refining Company
of New Jersey

"HANDS OFF"—*the policy of the sugar refiner all the way through the plant—is possible to a large degree because most of the product is moved by pumping in liquid form, or is conveyed in crystalline form by belt conveyors or bucket elevators in the same sort of equipment used in handling flour in a flour mill or bakery or sugar in a large candy factory.*

OUR raw material, known in commerce as raw sugar, is a sticky, brown mass of sugar crystals and adhering sirup, with an actual sugar content ranging between 95 and 97 per cent. The impurities, varying in kind and quantity, with every shipment received, consist of coloring matter, waxes, gums, and mineral salts, the ease or difficulty of the refining process being determined by the nature as well as the quantity of this extraneous 3 to 5 per cent.

The refinery removes color, mechanical and chemical impurities, and microorganisms, as well as the odor and

strange tastes inherent in raw sugar. Throughout the process, contact with human beings is religiously guarded against, and the materials used are most carefully watched by the chemical and engineering staffs.

For economical operation the refinery should be located in a good harbor, served by railroad sidings and good roads; but for proper sanitation and purity of product a plentiful supply of potable water is absolutely necessary. Even though the water is of excellent quality, meeting the standards of state health boards, yet, to guard against after-growths and rust in the water mains, it usually is filtered at the refinery before coming in contact with the sugar.

Labor, another very important factor in the plant operation, is not chosen haphazardly. Every man desiring employment must appear before the factory physician, whose rejection is final. The foreman is held strictly responsible for the cleanliness of his department. He is supplied with barrels, all plainly marked "Rubbish," and with a number for the purpose of identification. These barrels are so placed as to be convenient for the intended use, and still not represent a hazard. An electric truck collects the barrels every 12 hours, and dumps and returns them empty and clean to the proper department. Rubbish is not piled in unslightly heaps, but is burned immediately in a specially designated furnace. The laborers find posters in their departments, as well as at important plant passages, stressing the relationship between cleanliness and safety. Such posters from the National Safety Council as "Sloppy is Slippery," with appropriate pictures, give the desired impression very clearly.

There also is a special cleaning gang which takes care of staircases, washing walls, painting machinery, tanks, and the like. A definite relationship between cleanliness and safety is established by making the chairman of the committee on good housekeeping report to the plant safety committee. Mechanics, carpenters, pipe fitters, and others must leave the job in good condition when they are finished. Though their time per hour is more valuable than that of common labor, it is cheaper in the long run to have them clean up the average small job just finished, instead of taking labor from some other work for that purpose.

Numerous windows throughout the plant admit fresh, cool air and lots of light. A dark corner may be a dirty corner. Therefore, the management of this plant has at times made costly changes, moving huge tanks and machinery just to cut another window in some particular place, thereby throwing more light on the subject.

The refining of sugar is characterized by the fact that there is practically no contact between human beings and the finished product. Sugar is handled for the most part in solution by pumps and through pipe lines; when in crystalline form it is transferred by belt conveyors, bucket elevators, and similar equipment. The raw sugar is mixed with a heavy sirup and allowed to flow into centrifugal machines, where the adhering sirup is thrown off by centrifugal force and the sugar crystals retained in the basket. A fine spray of water is played on the sugar, which further washes the sirup from the surface of the crystals, leaving the partially purified washed sugar in the basket.

The washed sugar is then dissolved, making a solution with a density equivalent to about 60 per cent sugar content, which is then heated to about 185° F. At this temperature a large percentage of the micro-organisms are destroyed, and at this density sugar has marked antiseptic qualities. This solution, however, is still dark in color and is cloudy. It also has an acid reaction, due to the organic acids present in the raw sugar.

Louis Lang

Milk of lime is added in sufficient quantity to make the sugar liquor very slightly alkaline. To determine this, the most delicate chemical methods are used in the plant and then checked in the laboratory. Diatomaceous earth is added at this point and the solution agitated by means of air, steam, or mechanical stirrers; whereupon it is filtered.

To achieve almost perfect filtration—even to remove micro-organisms present—the cloths of the pressure filters are coated with a thick film of diatomaceous earth, after which the sugar solution is admitted to the presses under pressure. The blanket of diatoms retains the mechanical impurities—even of microscopic dimensions—only a brilliant, sparkling liquor passing through the filter. In order to make the higher grades of granulated sugar, the straw-yellow color of the liquor and the minerals still in solution must be removed, which is accomplished by the use of bone black.

To the layman the action of bone black appears almost magical. Huge cylindrical tanks are filled with freshly burned bone black and the sparkling straw-colored sugar solution allowed to flow under slight pressure from the top through to the bottom. As the liquor emerges from the filter it is absolutely clear and water-white. Moreover, the mineral salts have been removed by the bone black and the solution is ready for crystallization.

Up to this point the raw sugar has been handled by machinery only, while in the liquid state tanks, pipe lines, pumps, mechanical stirrers, and closed filters are used for conveying and processing. Instruments of precision, such as thermometers, pressure gages, and the like, are permanently installed wherever needed, making unnecessary the human contact that would be required with portable instruments. Instruments for gaging liquid levels in tanks are so installed as to be easily read at a distance, making it unnecessary for attendants to look over the tops of tanks. Naturally, such tanks can be kept covered.

Returning to the process, the sugar liquor, now water-white and free from soluble salts, is pumped to the vacuum pans, where it is skillfully boiled to a grain. Observation glasses from top to bottom make it possible for the operator to see the boiling mass, and a "proof stick" allows a small sample to flow out for close examination. Accurate thermometers and vacuum gages, permanently installed, render possible scientific control of the process. In the pan the sugar boiler concentrates the liquor until it crystallizes out, so controlling the growth of the crystals as to achieve a fairly uniform size of grain with a maximum yield. Next, the bottom of the pan is opened and the magma of crystals, with adhering mother liquor, flows by gravity into mixers below the pan.

From the mixers the magma flows by gravity to the centrifuges, where again centrifugal force separates crystals from adhering sirup. The mass, while still in the machine, is automatically washed with a fine spray of filtered hot water.

This wet white sugar drops from the centrifugal machines to bucket elevators, by which it is lifted back to higher levels, where it is dried in granulators—long rotary cylinders through which heated air is drawn by fans. Scoops are so arranged in the graulator as to lift the sugar and drop it repeatedly as it moves through the machine, a current of hot air removing the moisture. The dry sugar, still quite hot, then falls to a similar granulator and is there cooled by a blast of cold air.

Inclosed screens assort the cooled sugar into different sizes, whereupon the sugar goes by gravity to the barrel-filling department or, by conveyors, to the package department.

Only new barrels are used, and each one is provided with a special crepe paper liner. As the sugar flows into the paper-lined barrel the stand upon which it rests is agitated mechanically, causing the sugar to settle. When the barrel is full it is immediately headed and sent to the warehouse.

As for bags, the same care to keep "hands off" prevails. A machine automatically drops an even 100 pounds into an open bag. The filled bag passes on a belt conveyor through a sewing machine, which sews the top together as

the bag moves on. In the package department, automatic machines make the package, weigh the product, fill, and seal the package.

The fact that sugar is so easily handled in solution is now being utilized by a number of industries. This refinery now markets two types of sugar solutions—one water-white, and the other slightly yellow. These are sold in drums and in tank cars. For city delivery the refinery uses a specially constructed glass-lined tank truck, which pumps the solution to the upper floors at the point of destination.

Sugar liquor is prepared in a special plant within the refinery, devoted exclusively to its manufacture. It is, of course, obvious that, with a greater depth of filter bed, more efficient filtration is possible. Thus, in the course of sugar liquor production columns of bone black—approximately 20 feet in depth—are employed, a depth of filter bed that results in a very high grade product. Every shipment of this liquor must be examined and approved by a plant chemist before it is permitted to leave the factory grounds. Much time and effort were expended in order that a sugar liquor of notable chemical and bacteriological purity might be offered to the food industries.

There is, however, the drawback that a sugar solution is susceptible to infection if not stored and handled in sanitary fashion. No plant should attempt its use unless it is willing to keep all tanks, pipe lines, and other items used with the sugar liquor clean, wholesome, and sanitary. In the use of sugar liquor there are no barrels or bags to handle, no danger of getting bits of wood and nails in the sugar from carelessly opened barrels, together with elimination of cost and trouble incident to making sugar solutions, and a fixed saving in the cost of the container.

Care in manufacture is by no means confined to the making of sugar liquor. A laboratory staff, working in shifts, keeps constant vigilance 24 hours a day over every phase of the refinery. Purity is watched at each step in the course of production. The engineering staff, as well as the plant supervising staff, is ever on the alert to maintain a high standard of efficiency as well as product purity.

Suggestion boxes are conveniently located throughout the plant and their contents are carefully examined. It is felt that the man on the job very often knows what he is talking about when he makes a recommendation. Pride in the working conditions and the surroundings, as well as in the product produced, goes a great way toward the maintennace of a high standard of purity.

Confectionery

By STROUD JORDAN
Chief Chemist, Henry Heide, Inc.
New York City

THE basic principles of sanitation are similar for all food plants. Healthy workers, sanitary conditions and the accompanying contentment are part and parcel of the plans of every progressive management. These facts are basic and so well known that they are mentioned only in passing. There are, however, certain phases of sanitation, sterilization, and materials handling in confectionery manufacture, peculiar to our industry and worthy of specific treatment.

Much use is made of starch for molding purposes. Standard sized boards are filled, molded and liquid confections are deposited. The starch serves a twofold purpose: that of shaping the resulting confection and drying it. If solid molds other than the starch type were to be used, only the exposed surface would dry, and such a process is not satisfactory. Where starch is employed an imprint is made by shapes, the liquid confection is pumped in and it assumes the special shape. Dry starch will take up moisture and while the surface which is exposed to the air will dry a little faster, drying takes place on all sides, proportional to the power of the starch to absorb moisture. When such goods are properly set and dry it becomes necessary to knock out, brush off, and collect the starch in a suitable container. Here is where cleanliness plays the major rôle.

Stroud Jordan

If the molding starch is to be used again it must be dried to re-create its original power of absorbing moisture. Such starch is easily contaminated with materials which are injurious, therefore the room in which boards are stored must be free from dust and dirt. Infection may set in when starch is allowed to remain very damp for an appreciable length of time. Care in handling and a temperature sufficient to sterilize, or a sufficient lowering of the moisture content to kill bacteria and mold spores, must take place. There is nothing worse than infected starch, and many cases of fermenting and bursting cream centers have been traced to this source. Proper sieving, drying and handling will eliminate this trouble.

The casting life of starch is directly dependent on the treatment it has received. It may last a year or more, but if it is allowed to hang around in an excessively damp condition for long periods or if tags from previous castings are not removed by proper screening, it will soon become unfit for further use. A handful of infected starch will ruin a whole new batch. The increase in reducing sugars must be watched. In wet starch, which contains more than 5 per cent of total sugars, fermentation may get a foothold. Moisture in excess of 12.5 per cent will furnish molds with a fertile field for propagation. Keep down moisture and watch sugar content if you would avoid infection and retain proper drying power. A satisfactory starch may show from 4.5 to 6.5 per cent moisture, according to the special drying use for which it is intended, but it should not be required that it absorb more than 2 per cent of moisture, based on total starch weight.

Sterilization of starch boards and those used for receiving dry centers constitute another vital problem. High humidity in a room, whether from excessive steam or outside conditions, will cause softening of the outside of such centers and a sticking to the boards. Periodic sterilization must take place. For this purpose a dishwashing machine of the power type will be found satisfactory. Boiling water with injected steam should be used, if one would prevent warping from slow drying. Any sterilization by means of steam and boiling water will prove satisfactory. Boards must be sterile and dry to handle starch, for dirty boards may carry infection into the starch itself.

Fumigation and preventive spraying is not different from the methods used in other food factories. Removal of trash in closed containers, as fast as it

KEEPING *the moisture content of the casting starch down to 12.5 per cent by prompt drying is as important in a candy plant as it is for a macaroni plant to dry its product quickly below the danger mark, for failure in both instances will result in mold growth. Fumigation is required in a confectionery plant just as it is in a flour mill, a bakery, a cereal plant, or other dry or semi-dry food manufacturing establishment, to rid the place of damaging insect pests.*

is gathered up, and the prevention of waste accumulation which may ferment, will go far toward eliminating most infection troubles. A weekly scouring of all floors with a hot solution of soap and sodium carbonate will remove dirt and spots. Drains should be located at such points that the boiling solution may be poured on the floors, scoured around and then swept into these drains. It doesn't take long to put a plant in spick and span order nor does it take long to dirty it up again if proper cleanliness is not practised. It has often been said that the floor of a food factory should be so immaculate that one could eat a meal from it and still relish the food. This is going a bit strong, but the cleanest should never be clean enough in the modern confectionery plant.

Hand trucks, used in hauling trays from room to room, must be kept clean. The bottom board of the stack rests on the truck and since such boards are stacked as the trays happen along, it is possible that this bottom tray may sit on the top of a full one on the next trip and drop dust and dirt into it from the jostle and jar it receives in transit.

Cold storage space must be watched carefully. Brine lines are necessary and attendant frosting cannot be entirely eliminated. Defrosting must take place periodically, generally over the week-end. To take care of the water which runs off, a gutter system sometimes is used and placed directly under the brine lines. If there is a stoppage in the gutter, not enough pitch to the line, or not enough water formed in any single defrosting operation to cause proper drainage, stagnant pools may be formed and molds grow therein profusely. Such gutters must be closely watched and cleaned regularly.

All moisture possible should be eliminated from working space which is under a cooling system. Temperature here is constantly changing from contact with outside air, as the doors are being opened and shut to receive or send out goods. The warmer air which rushes in will increase humidity as it is chilled to room temperature. This factor must be closely watched where nuts and fruits are stored, if molding and fermentation are to be eliminated.

Storage space for containers must be watched. If paper or wooden containers are stored in a damp cellar they develop a moldy and musty smell which is transmitted to future contents of candy. They may even seed down the confection with molds. In this connection it should be remembered that excessive moisture in a container of this type will be absorbed by the confection and fertile conditions for fermentation and mold propagation be created.

To sum up the situation in a few words, one need but remember that cleanliness is an essential in the confectionery plant; that sterilization of space as well as materials must be practised; that removal of waste as fast as it is gathered is necessary; that personal cleanliness must be practised by all; and that when cleanliness becomes a part of the daily routine of every worker the problems of sanitation are already solved.

Beverages

By FRANK C. GEPHART

Consulting Chemist
New York City

ADVERSE CHANGES in the finished product characterize the effect of improper cleanliness and sanitation in the manufacture of carbonated beverages. These changes involve the following types of trouble, all of which may be caused by bacterial growth in a comparatively short time after the goods have been manufactured: sedimentation or turbidity; color changes; flavor changes with increased acidity, and resulting unmerchantability.

The keeping qualities of a carbonated beverage depend on: putting together raw materials that are free from micro-organisms; preventing the growth of any organisms which may accidentally find access into the beverage by the use of carbon dioxide and proper acidity, the latter of which usually is citric acid; bottling in sterile bottles; and capping with clean caps.

Water may be freed from bacteria by a number of methods, the most common of which is filtration. Other methods are by the use of ozone and, in rarer instances, distillation. Proper filtration of extracts and sirups will free them from bacteria which, although dormant in concentrated solutions, at times may grow actively in the more dilute solutions found in the bottled beverage. Clean, sterile bottles and clean caps are essential to successful beverage manufacture.

When a well-controlled beverage plant is operating continuously very little trouble, if any, caused by growth of micro-organisms in the piping will ever be experienced, but after periods of inactivity this problem may arise. This is particularly important in the pipe line between the sirup filters and the filling machines, for, if not thoroughly cleaned, drained, and sterilized after a shut-down, the residual sirup will mold in the pipe and re-infect all subsequent sirups with a heavy infection that will make for inevitable trouble. Proper handling of this department requires thorough washing out of such pipe lines, followed by draining and steaming under low pressure to sterilize them.

Because of the fact that the sterile

Underwood & Underwood Studios
Frank C. Gephart

ingredients are to be put into sterile bottles it is essential that the bottle washer which is to accomplish this sterilizing process must be working satisfactorily at all times. The mere fact that an endless chain of bottles is passing through the washer by no means assures that the machine is working efficiently. The alkali must be up to the required strength and should be tested for this point at regular intervals.

Buchanan and Levine, in making a study of this operation for the American Bottlers of Carbonated Beverages, have emphasized the necessity of a concentration of alkali of not less than 3 per cent and—another point of equal importance—that the temperature of the washing solution should be up to 130° F., with a contact period of 5 minutes. The alkali wash water should be changed at frequent intervals; it should never be allowed to become thick and viscous through the accumulation of extraneous matter. Much trouble can be avoided by proper cleaning of the bottles and by careful attention to this phase of the manufacture. After the bottles have been thoroughly cleaned it is essential that they be handled in such a way that re-infection cannot occur. This, of course, means that sterile water must be used for rinsing.

When ozone is used as the means of sterilizing the water, proper care must be used to secure a complete removal of this active oxidizing agent from the water before carbonation, or it will cause inevitable flavor changes in the course of a few weeks. It is perfectly possible for a plant that is endeavoring to do a perfect job on the score of cleanliness and sanitation to fail to remove the ozone completely, and the product suffers as a result. This indicates that the room where the water falls over the coolers should be properly ventilated.

It is preferable that all equipment have a glass lining, or its equivalent. If not, metallic contamination frequently may lead to the formation of insoluble metallic citrates, appearing as flakes in the finished product.

As to the bottles ordinarily used with

carbonated beverages, the custom is to accept from the trade all that are in usable condition, supplementing them by enough new stock to cover losses from non-return and breakage. Returned bottles are scanned for evidences of chocolate residue, or for such extraneous matter as paint, shellac, and what not. Such dirty bottles are either discarded or put to soak for a period of hours, in order to soften adhering matter. They are then added to the other returned bottles and washed in the usual way.

There is, admittedly, an economic argument in favor of conserving the supply of bottles, an argument that at present seems convincing to all but a few manufacturers of bottled beverages. Whether or not an establishment is to accept the principle of "No credit for returned bottles," is necessarily a point that each operator must settle for himself. The arguments in favor of the use of none but new bottles center in the technical point of relative certainty that one is thereby dispensing his product in none but fully sterilized containers.

The use of new bottles, rather than old, greatly facilitates the maintenance of perfect sanitation and cleanliness. Very few people rinse out a bottle after pouring its contents into a glass. The beverage adhering to the bottle very quickly ferments and molds, and by the time such bottles are returned a visible solid mold growth often is apparent. The use of such bottles, even with the bottle washer operating under the best of conditions, may easily be the source of endless troubles arising from contaminataion. Again, an old bottle may be clean bacteriologically through the use of the bottle washer and still be far from being clean and attractive. It is a common occurrence to find beverage bottles in use in paint shops and other non-food establishments. Eventually, such bottles may find their way back to a bottling plant, and the very best bottle washer will not clean them. The best way of guarding against this source of contamination, unless the most careful scrutiny is exercised in sorting out and cleaning such bottles, is to use new bottles and an efficiently operating bottle washer.

Bottle caps have been known to be a source of trouble, particularly where inferior liners have been employed in which the adhesive holding the cork composition together has been heavily infected with bacterial spores that eventually cause spoilage of the finished product.

To sum up, the bottler, assuming that he fully understands the sanitary rules and regulations of the American Bottlers of Carbonated Beverages, should be cognizant of the following:

A clean finished produce can be obtained only through careful control and frequent examination of all the possible sources of bacterial and metallic contamination, paying especial attention to the use of efficient filters; new bottles, if practicable; if not new bottles then old bottles that are *clean;* an effectively operating bottle washer; using clean bottle caps and controlled carbonation and acidity. An infected beverage resulting from the neglect of any of these precautions may easily become a menace to health, and will invariably lead to returned stock and a dissatisfied trade. The manufacturer of carbonated beverages can, much to his financial profit, make good use of applied chemistry and bacteriology.

Bottle Washing and Its Control

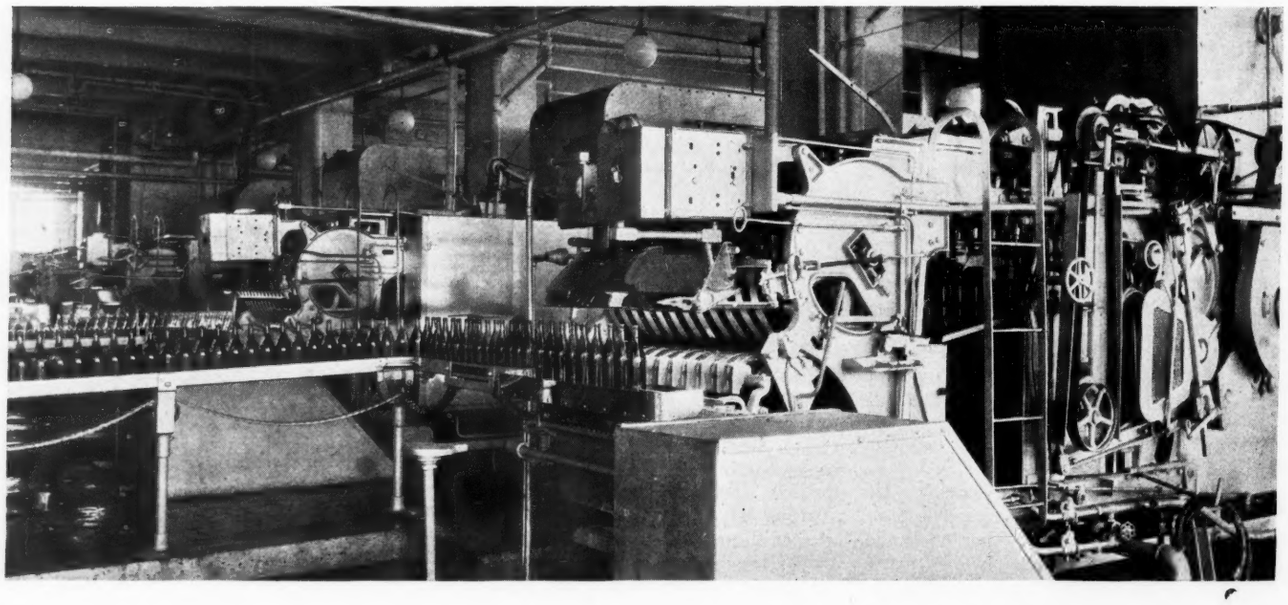
EDITORIAL STAFF

WORKING under the terms of a research fellowship of the American Bottlers of Carbonated Beverages, at Ames, Iowa, J. H. Buchanan and Max Levine, of Iowa State College, have formulated several basic principles underlying the sterilization of glass containers. Their work was published in August, 1929, as A.B.C.B. Educational Bulletin No. 1 (revised), obtainable for $1 from the bottlers' national headquarters in Washington, D. C., and is of interest to all food manufacturers who use glass containers of any sort.

Among the technical points determined scientifically are: in machine bottle washing, caustic concentration of the soaker solution and the time of exposure thereto are interchangeable factors—for example, each 50 per cent increase in such concentration permits a 50 per cent reduction in the time of washing; for temperatures ranging from 120° to 160° F., an increase of 10° F. is equivalent to a 50 per cent increase in caustic concentration; the temperature of the first rinsing solution should be between 100° and 110° F.; the addition of sodium carbonate or tri-sodium phosphate to sodium hydroxide solution increases the germicidal efficiency of the solution, although at a diminishing rate above 3 per cent of added salt. The carbonate is slightly the more effective in this respect.

They recommend a washing solution compounded of 60 per cent caustic soda and 40 per cent sodium carbonate, a 3 per cent solution being used at 130° F.

Meyer-Dumore Bottle Washers at Hoffman Beverage Company, Newark, N. J.



in a machine that operates on not less than a 5-minute period of washing.

Bottles containing chocolate or other dried material should be thoroughly soaked before going to the washing machine; caustic strength should be brought back to normal at the end of each day's run; the solution should be changed after each 60 hours of operation; rinse water, at 100° to 110° F., should be of as good quality as that used for the beverage.

For the removal of rust in bottle necks, soak in a 10 per cent muriatic acid solution, rinsing thoroughly before going to the machine; for cloudy bottles, soften the rinse water, or add tri-sodium phosphate to the soaker solution; for foaming, harden the soaker solution by adding lime at the rate of ½ pound to each 100 gallons.

The foregoing conclusions were inductively derived from experimental data, both laboratory and commercial. There has been evolved therefrom a germicidal index, the purpose of which is to permit all who buy detergents to do so intelligently. A 60/40 mixture of caustic soda and sodium carbonate is given the value of unity, the index numbers ranging from 0.67 for all caustic to 5.8 for a mixture 95 per cent carbonate. On the same scale, a 60/40 mixture of caustic soda and tri-sodium phosphate has a value of 1.04, the same relative range being 0.67 and 7.5.

An important feature of this very helpful booklet is the A.B.C.B. Alkali Test, which takes the form of tablets for use by bottling-plant operatives in determining the percentage of alkalinity in any solution. Apparently, results so obtained are closely comparable with check determinations in the laboratory by standard titration with methyl orange indicator.

Other items of more or less general interest are discussions of chlorine and the reasons for not recommending its use; of the errors introduced by the use of the Baumé hydrometer in determining the true percentage of caustic; and a proposed method for the rejuvenation of soaker solutions by treatment with lime.

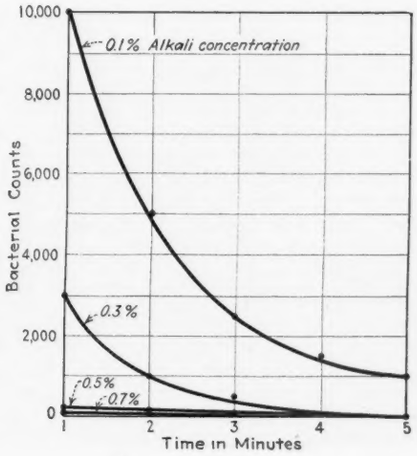
Cleansing and Sterilizing With ALKALINE DETERGENTS

By C. S. MUDGE
University of California
Davis. Calif.

WITHOUT seeking to minimize the really great advances in shop sanitation—far-reaching in extent and often revolutionary in nature—characteristic of present-day commercial manufacture of wholesome foods, it still is unfortunately true that frequently a certain basic cleanliness is overlooked. Floors, walls and utensils are always washed, but too frequently the washing is a final operation of the day done by a weary crew. After having been connected with various branches of the food industry for 15 years, this statement is made after mature thought and because the facts seem to warrant it.

In the meat-packing industry, the dairy industry and the canning industry, the long periods during which the material is in process of manufacture offer an opportunity for building up a thin film of fat and protein upon all surfaces with which the food comes in contact. This film harbors bacteria, which multiply with enormous rapidity between the end of one day's run and the beginning of the next. Unless this fatty film is thoroughly removed each day it offers an ideal environment in which bacteria may thrive. To be sure, meat is smoked or chilled, milk is pasteurized, and vegetables and fruits are sterilized in cans. In other words, the consumer is protected; for, generally speaking, processed food retailed in local shops may be said to have had its bacteria reduced to the vanishing point.

Fig. 1—Relation between strength of NaOH and time, as measured by bacteria surviving



Although factory-made food is fast approaching an ideal, this fatty film exists today in many plants where food is prepared, and the ideal would be still nearer were this film to disappear entirely. Everyone in the food industries knows of its existence, but its removal is as much a problem today as it was many years ago. Plant superintendents throughout the land will challenge this statement, countering it perhaps with one to the effect that alkali is used in their plants to remove the aforesaid film. True; alkalis have been used for years to such an extent that in one case, at least, the trade name of the product has become almost synonomous with the word alkali itself. But do we know how alkalis work, how effective they are, and whether they are germicidal as well as cleansing in their action?

It is rather significant, in view of the foregoing, that in the last few months several papers have appeared in the scientific press which have attempted to solve some of these perplexing questions. For those who may be interested, a bibliography of these papers is appended to the end of this article. The alkalis themselves can be classified in three general groups: the sodium hy-

droxide—carbonate—bicarbonate group, the tri-sodium phosphate group, and the newer colloidal alkali group.

The nature of the first two groups is self-evident from their names. The last group is made up of one or the other of the first two with the addition of some active substance supposed to be of colloidal nature. Their appearance on the market is a direct result of the extended research upon colloids that has taken place within the last 10 years.

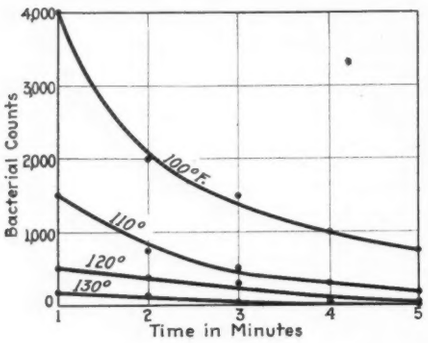


Fig. 2—Relation between temperature and time as measured by bacteria surviving

In fairness to all concerned, it might be well to give a word of caution in this connection, as the temptation to exploit new knowledge in any field of science is too great to be resisted by many. One must bear in mind the story of yeast, of the vitamins and, recently, of acidolphilus when approached by too glib a salesman. Nothing in what is said here is intended as disparagement of an honest attempt to use the knowledge that the colloid chemist has placed at our disposal, for it is quite evident to the writer that a colloidal alkali based on fundamentally sound principles is a possibility. Such a product, when and if it appears, will win by sheer merit against the keenest of competition.

The mode of action of the alkali is not fully understood. Because of the fact that a fat is to be removed by an alkali, saponification seems to offer an easy solution of the question, yet it seems that it is not as simple a story as that. A much more rational explanation is that of emulsification. By this process the fat is loosened and then broken up into countless droplets which, temporarily at least, fail to coalesce again into a continuous layer and are flushed from the system as small fat droplets. In a recent paper Parker has attempted to evaluate the relative efficiency of the various alkalis and says, in part:

> By adding equal quantities of melted milk fat to given aliquots of 1 per cent aqueous solutions of the alkalis to be tested, at a constant temperature, it is possible to evaluate relative emulsifying properties by measuring the size of the droplets rising to the surface, and determining the time consumed in forming fat layers of uniform thickness. In the author's experience 45 deg. C. (113 deg. F.) is the most practical temperature for these tests. It is suggested that the water supply used in the washing operations be used as the solvent in order to approximate practical conditions.

It is the opinion of Parker that sodium hydroxide will do this well, but that tri-sodium phosphate will do it better, though the carbonates are not very efficient in this respect. It is Parker's observation also that the mixture of sodium hydroxide with the phosphate hinders the action of the phosphate. Temperature, of course, plays a very important part. Nor should one belittle the use of human energy in helping the alkali do its work, bearing in mind in this connection that a good brush is invaluable. In cleaning long pipes, such as are found in a milk plant, a brush should have a handle long enough to reach entirely through the pipe. Otherwise, the material loosened at one end is all too likely to be pushed back and forth in the pipe, being always just beyond the end of the brush.

Incorporated with the fat is some dirt, many bacteria, and numerous particles of protein. Many of these are exceedingly small and seem to stick closely by adsorption to the surface upon which they are found. This nonfat component of the film is removed by peptization, a process by which alkalis, and even other things, can cause the suspension of solid particles. Such a suspension is almost a solution, India ink being typical thereof. Further, it is well known that merely cleansing one's hands with water does not of necessity remove the dirt. The use of soap will, however, suspend the dirt and render the hands clean. This phenomenon is due to the fact that the soap absorbs the particles more strongly than do the surfaces. Alkalis act in the same way. When the film particles are once in suspension, flushing is then an easy process. As already mentioned, however, the mechanism of the film removal is not as well understood as it might well be, but future work doubtless will tell us much.

OF recent years the demand of the user of alkalis has been that they shall sterilize the surface as well as cleanse it. Recent work on alkalis has attempted to solve this question. Mudge and Lawler showed that there are three factors of importance in the use of alkalis: time, temperature, and concentration. As they were especially interested in the subject from the standpoint of the washing of milk bottles, they chose 40 dirty bottles, using the rinse water obtained therefrom for their studies. Counts of the bacteria were made after varying periods of time when employing alkalis of different concentrations at different temperatures. The accompanying graphs show the regularity with which these workers obtained decreasing counts in respect to time for different concentrations (Fig.1) and for different temperatures (Fig. 2).

These workers also showed the existence of an interesting relationship, termed the isolethal effect, and shown in Fig. 3, the surviving bacteria being given for each factor of time and temperature. It will be noticed that lines parallel to one another can be drawn through counts of equal magnitude (isolethal lines) with a zone of sterility indicated. In this zone of sterility different combinations of the two factors—time and concentration—can be expected to give sterility with a reasonable degree of certainty.

Since the alkali solutions, as used in the industries, are quite concentrated, it is natural to think of the possible relationship of the alkalinity to the hydrogen ion concentration. It is doubtful whether such a direct relationship exists. A few drops of a strong alkali solution would carry a beaker full of distilled water well within the effective range of an alkali, but the addition of a small quantity of protein material (casein, peptone, and the like) would quickly decrease the pH to a point far below that given in the distilled water.

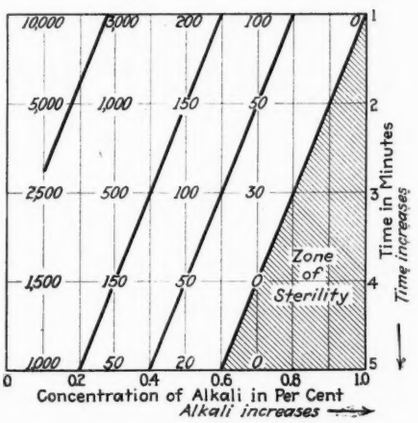


Fig. 3—"Isolethal" effect with respect to time and concentration of alkali

Such material acts as a buffer and would remove from the system a large part of the hydroxyl ions, which would result in a corresponding increase in hydrogen ions and a decrease in the pH. This buffering action is more marked as the hydrogen ion concentration is increased from pH 13 to pH 12 and pH 11. It must be remembered also that a pH of 13 is ten times stronger than one of 12, and a hundred times stronger than one of 11, and for this reason the effect of buffer would be less marked at an alkalinity represented by pH 13 than at pH values representative of less alkalinity. For this reason, too, the effective pH of alkali solution—for pH does play a part—is in a narrow range.

Levine and his co-workers are of the opinion that there is something other than the pH alone that is responsible for the lethal effect of alkali. In these studies a culture of a spore-forming organism, the *Bacillus subtilis*, was used. This culture was forced into a spore state by aging and the spores gathered and mixed with dry sterile lactose, thus giving a constant source of test organisms. Levine and his co-workers then studied the action of alkalis of various kinds, in various concentrations and at different temperatures, upon these spores, determining the time necessary to kill 99 per cent of them under the different

conditions. The results are of great interest, but too voluminous for full recital here. One of the interesting experiments dealt with the killing time of three alkalis, sodium carbonate, sodium phosphate and sodium hydroxide, maintained at the same hydrogen ion concentration, pH 11.35.

In order to attain the hydrogen ion concentration of pH 11.35 it was necessary to make a solution of sodium carbonate equivalent to a normal sodium hydroxide (NaOH) solution. The sodium phosphate solution was equivalent to such a solution of 0.0545 normality and the sodium hydroxide solution was of 0.0065 normality. Thus it will be seen that it took about 200 times more sodium carbonate and about 20 times more sodium phosphate to duplicate the hydrogen ion concentration of sodium hydroxide itself. The killing times for the carbonate, phosphate, and hydroxide at 70° C. (158° F.) were 120, 163 and more than 220 minutes, respectively. In this experiment the carbonate was more effective than the hydroxide, due no doubt to its effective mass. Levine seems to think that a reserve of undissociated salt functions as a constant supply of hydroxyl ions. He concludes also that for each alkali, taken individually, the lethal effect is a direct function of the hydrogen ion concentration.

Myers, on the other hand, is of the opinion that the hydrogen ion concentration is a direct measure of the effectiveness of an alkali, but asserts that the buffer index and the osmotic pressure are factors of great importance. Table I is taken from one of Myers' papers. Due to the nature of this paper, some of Myers' material is omitted from Table I, which explains the apparent difference in pH of various sodium hydroxide solutions. This is explained by stating that some of these solutions have been partly neutralized. It will be seen that the hydrogen ion concentration decreases quite regularly from pH 13.36 to pH 9.10. The killing time for these solutions increases quite as regularly as the hydrogen ion concentration increases. There seems to be a correlation of some importance.

Table I—pH Values for Various Solutions With the Killing Time in Minutes

Solution No.	Solution	From Titration Curve (pH)	Buffer Index	Osmotic Pressure (Atmospheres)	Time Required to Kill 99 Per Cent of Spores (Minutes)
1	NaOH.....	13.36	37.6	21.2	7.1
1	NaOH.....	13.10	17.0	21.4	16.2
3	NaOH.....	13.12	17.0	10.6	24
4	$NaOH-Na_2CO_3$	13.11	17.0	17.2	16.3
5	$NaOH-Na_3PO_4$	13.17	19.5	18.7	12
6	Na_3PO_4.....	12.36	5.4	18.5	79
7	$NaOH-Na_2CO_3$	12.27	2.0	16.9	184
8	$NaOH-Na_3PO_4$	12.22	4.0	20.5	110
9	NaOH.....	12.22	2.1	21.0	182
10	NaOH.....	12.45	2.7	2.0	326
11	Na_2CO_4.....	11.39	1.4	12.7	444
12	Na_2PO_3.....	11.35	6.2	21.7	300
13	$NaOH-Na_2CO_3$	11.30	1.0	17.3	540
14	$NaOH-Na_3PO_4$	11.28	2.9	21.3	480
15	NaOH.....	11.40	0.4	20.8	618
16	Na_3PO_4.....	9.10	0.3	25.5	4,500

In defence of his buffer argument, Myers points to solutions 12, 13 and 15. Solution 12 has a high buffer index (6.2), while those of 13 and 15 are 1.0 and 0.4, respectively. All of these solutions are of substantially the same pH, but solution 12 is considerably more effective in its germicidal effect. Myers obtained his buffer index from titration curves given in his paper, taking the index number directly from the curve. It would seem that Levine's undissociated salt theory and Myers' buffer index might be one and the same. All of the work to date seems to point to the fact that cleansing solutions of the value of pH12 can be employed with a great degree of safety. This will kill both *B. coli* and *Mycobacterium tuberculosis* in a period of 5 minutes if a temperature of 60° C. (140° F.) is used. This should be ample for such purposes as washing milk bottles and the like. If this hydrogen ion concentration should be used, there is an indicator—tri-nitro-benzene—which is effective in this range and gives a deep orange color in solutions above pH 12, fading to colorlessness at pH 11.5. It is not a stable color and determinations should be made rapidly.

As a closing statement, let it be said that protein materials certainly do buffer alkali solutions. A washing solution may be made with a salt requiring a large mass of material; it may have a pH of 12.5 or better; it may have proved an effective germicide in the laboratory; but such a solution should be maintained at the pH of 12.5 constantly if it is to be effective. For this reason bottle washers in dairy plants are made now with dosing tanks which are designed to constantly feed small quantities of fresh alkali into the washing chamber. This is good practice and should be diligently followed.

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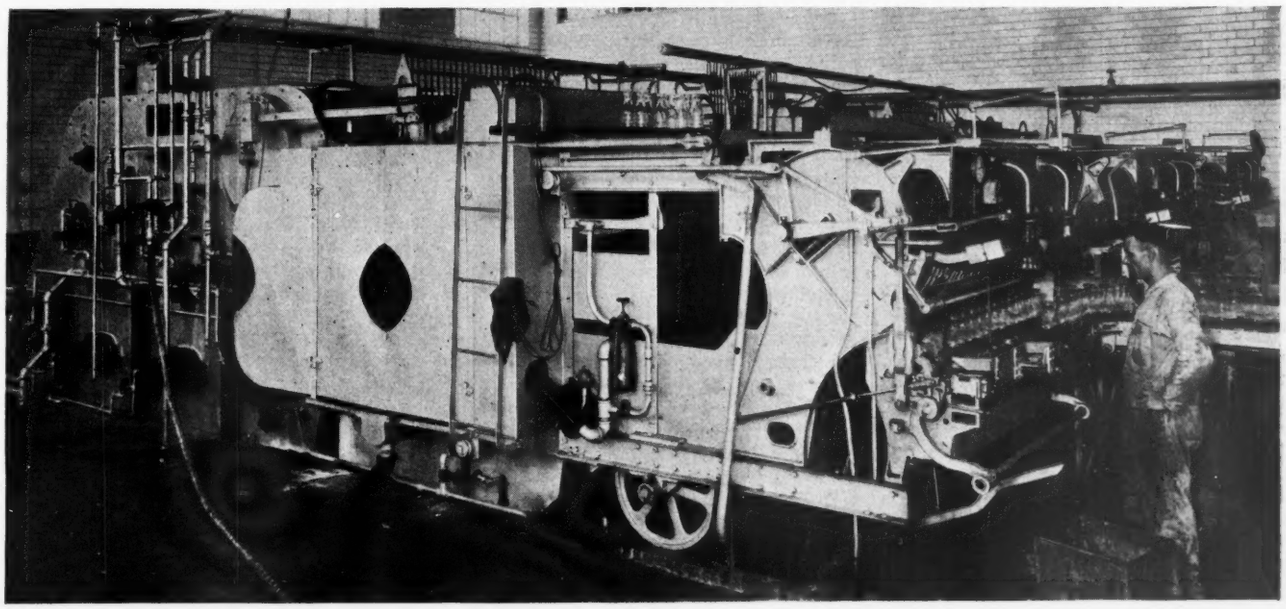
Meyer-Dumore bottle washers at the Wieland Dairy, Chicago; the bottles are fed in the basement and can be dimly seen ascending through a hole in the floor under the machine



How CONSTRUCTION MATERIALS *And* DESIGN *Influence* Cleanliness and Sanitation

OF FOOD-PROCESSING EQUIPMENT

By LAURENCE V. BURTON
Assistant Editor

ANYONE experienced in the practical work of food manufacture knows that some kinds of equipment are easy to clean and others are very difficult to maintain in proper condition, and that some forms of equipment have no bad effects on the products while others have serious defects in this respect. When the equipment is hard to clean and keep clean, or when it adversely affects the product itself, the causes usually are to be found in its design or the materials of which it is constructed.

Food comes in contact with both materials-handling and processing equipment during its course through the factory to the final package or shipping container. Solid materials are handled in conveyors, chutes, trucks, boxes, and tables, all of which usually are of large size and present flat, easily accessible surfaces, capable of relatively easy

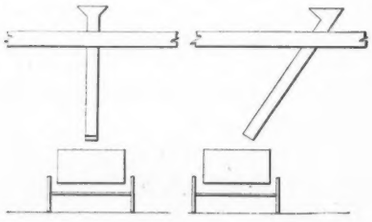


Fig. 1—Short straight chutes

cleaning; whereas liquids are nearly always handled through pipes, hose, fittings, valves, pumps, and tanks. The latter group is nearly always of small diameter, nearly always too small to reach into, and often not easily cleaned, except when specially designed to facilitate this end. Therefore the greatest problem of cleaning and sanitation of equipment for materials handling in food-manufacturing plants will be found in that used for liquid food products. Processing equipment is of large size as a rule and usually permits easier cleaning as contrasted to the small equipment for handling liquids.

The more difficult problems of sanitation and cleanliness are confined largely to those industries where the food is either damp or wet when actually in the equipment.

Looking at the situation from a different viewpoint, the practical technical problems of cleanliness and sanitation are by far greatest in the industries handling liquid foods, notably in the dairy industry, and, by virtue of the magnitude of the latter problem, so much effort has been expended on it that the equipment of the dairy industry is better designed to facilitate adequate cleaning than that of any other field. Between dairy manufacture, with its extreme problems of cleanliness, and possibly ice manufacture or perhaps flour milling, with what appear to be the least difficult problems of cleaning, all the other fields of food manufacture are found. It would be very venturesome, however, to attempt to establish a scale of relative difficulty of cleaning in food-manufacturing groups. Each has problems of its own that are peculiar to itself, but all have many problems common to all fields arising from the design and construction of their equipment.

Design of food-manufacturing equipment from the standpoint of cleanability is influenced by two principal conditions: industrial necessity and legal requirements. The latter influence is found largely in dairy manufacture, where regulations of various boards of health and milk commissions impose a very rigid code upon the dairyman and, in turn, upon the makers of dairy equipment. A part of the effect of such codes is found in the resultant design of equipment, and another part is manifested by the obligation to use certain control apparatus such as recording thermometers and automatic temperature controls.

No effort will be made here to differentiate the underlying influence in equipment design, for a broad viewpoint of the subject leads one to believe that the legal requirements are but examples of anticipated recognition of industrial necessity. The board of health regulations have anticipated, by many years in some respects, the conditions of de-

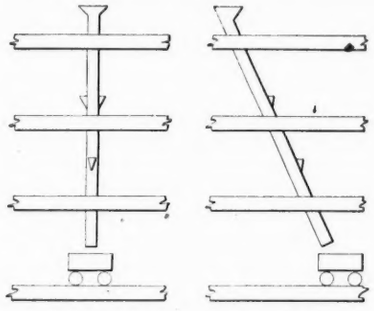


Fig. 2—Long straight chutes with cleaning louvers

sign that probably would naturally have come into existence as a result of industrial competition to produce better products.

A full discussion of design from the standpoint of ease of cleaning is one that would require all the pages of a good sized book, and hence only the outstanding features can be sketched. To illustrate what one encounters in seeking material for such an article may be cited the plant which one of the editors recently visited where it is quite likely that much expensive hand labor in cleaning might have been avoided every day had a careful study previously been made of the rate of heat transfer between large warming tanks and their contents. In this case material was literally cooked onto the walls of the tank because of a high temperature differential between the heating medium and the contents. A different method of heat application with a lower tem-

perature differential would appear to be the means of a considerable saving of direct labor.

To avoid repetition of an obvious fact in the subsequent discussion of types of food-manufacturing equipment it should be understood that in all cases the materials of construction that are in actual contact with food materials must be such that they will have no adverse effect upon the food. In certain cases a brief discussion will be given where it is felt that the subject warrants it, but where a discussion of the materials of construction is omitted the common-sense view, stated above, should prevail.

All surfaces should be of solid materials, impervious to water, whether products are wet or dry, and in all cases should be free from cracks, crevices, open seams and inaccessible corners. Trucks, boxes and tables pre-

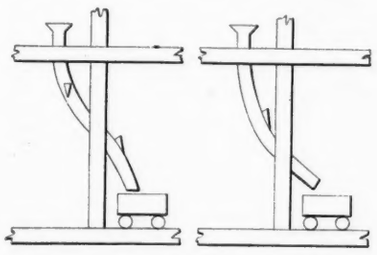


Fig. 3—Curved chutes with cleaning louvers

sent features too well known to require further mention. Chutes and conveyors, however, are not so simple from the standpoint of cleanliness and deserve proper attention.

Straight chutes of closed types, such as are shown in Fig. 1, are simple and easy to clean. Solids will slide, roll or flow and, when wet, often will leave traces of material that must afterward be removed, usually by washing. No particular problem is presented except when they are very long, in which case the design in Fig. 2 will help their cleaning. The openings or louvers are places in which a hose may be inserted for washing up.

Curved or bent chutes are to be avoided wherever possible, but when their employment is necessary, provision should be made to facilitate cleaning at the inaccessible parts of the curves by suitable cleaning louvers, as shown in Fig. 3. No definite rule can be established regarding the proper placing of cleaning openings. The nature of the product and the nature of the service expected of the chute, as well as the degree of curvature or length of chute, must influence their location.

Dough chutes, used in bakeries, are best kept as short as possible—usually 2-ft. length being sufficient—and hung so that they may be taken down daily for washing out. Open-type chutes present no special problems because they are accessible from one side throughout their length.

On dry products the drag conveyor offers no particular problems of cleanliness if it is not inclosed in some form of housing. When housed, a provision should be made for removing sections of the cover for cleaning purposes.

When wet products are conveyed in drag conveyors a distinct problem is encountered in the nature of drip from both the advancing and returning flights. Drip pans should be installed to catch the liquid, which becomes a nuisance if allowed to fall on other equipment, on floors or on workers. However, the drip pan itself presents a problem of cleaning that needs attention, for when neglected a very nasty condition may arise although not in actual contact with food. Horizontal-travel drag conveyors should have drip pans that slope toward a drain pipe and should be freely accessible from many places for washing with a hose.

Drip pans on inclined drag conveyors sometimes are neglected because their steep slope often engenders the erroneous belief that they are self-cleaning. The pans for this type of conveyor can be constructed with louvers in the pan that make for easy cleaning, as is diagrammatically shown in Fig. 4. Washing the conveyor itself presents no problems of moment.

Rubber belt conveyors handling wet materials sometimes are constructed so that drip gets onto the interior side of the belt next to pulleys. Often they are so housed that cleaning them out is a virtual impossibility except by dismantling the whole unit. Proper openings to admit hoses or brushes should be provided to wash this place. A flexible guard between the sides of the conveyor and the belt, such as shown in Fig. 5, can be made of rubber belting and will serve to retain most of the material and water on the belt.

The best designed screw conveyors have a trough that closely fits the contour of the screw so that all materials will be carried forward. When the fit is not close a deposit of material may accumulate that eventually may afford a breeding place for insects if a period of inactivity ensues. At least one large

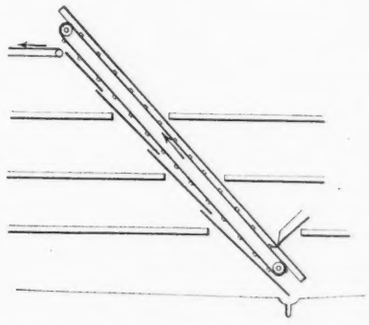


Fig. 4—Drip pan under a long drag conveyor arranged with cleaning louvers

flour miller believes that all of the many screw conveyors in his industry should have drop bottoms that will permit easy dumping of residues of flour.

Bucket elevators for flour were formerly canvas belts bearing small cups riveted in place and running in wooden housing that afforded no means for

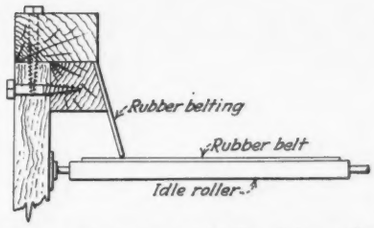


Fig. 5—Method of retaining drip on flat rubber belts

cleaning out the webs of insects that formerly bred in such places. The boot at the bottom of the elevator was another place that was impossible to clean out. The latest design involves two parallel chains which carry the buckets between them and run in metal housing. Clean-out and inspection doors are provided every few feet and at the bottoms of the boots. This is an important improvement over the older design.

Oil-less bearings on flour machinery constitute an improvement in flour-handling machinery, for by the use of this sort of bearing the possibility of machine oil getting into the food is avoided.

Flour scales are now being equipped with an electric vibrator that is started when the flour is dumped. It eliminates the necessity of pounding the scale hopper, thus battering in its sides, and also insuring that the scale is self-cleaning.

Piping and pipe fittings for liquid food products involve materials of construction, design and installation. Good design involves such important matters as provision for perfect continuity of the interior surface as found in sanitary pipe lines in dairies. These pipes have ground joints and International Pipe Standard square threads that permit easy dismantling and assembly, as shown in Figs. 6 and 16. Tin-lined pipe is shown in Fig. 7, and glass-lined pipe in Fig. 8. The problem of proper design and proper installation is solved by avoiding all pockets where liquids can accumulate and by hanging pipe in such a way that the liquid always will drain toward a proper place for its removal when cleaning.

Pyrex glass pipe also is used, and it has the advantage that it is transparent, thus enabling one to see at a glance whether or not the pipe is clean. Although it is glass it will withstand alternate hot and cold water without fracturing.

Dairy or sanitary piping is made so that it may be easily dismantled with every clean-up, as this is one of the requirements of most health ordinances. The paper gasket is beginning to appear for use in dairy pipe joints. It can be used only once and must be replaced daily—a fact that the law approves.

The simplest valve in the food industry is a bronze or Monel plug attached to the end of a cypress stick. It is inserted into a ground-joint outlet of catsup and tomato-pulp cooking tanks in the manner shown in Fig. 14. Its virtue lies in its ability to close the outlet on the inside of the tank and prevent

the formation of a pocket between the tank and the valves usually used in outlet pipes.

Cocks find a great variety of uses in liquid food handling, and also are of great importance in the dairy field. When a cock wears, however, it is very liable to leak, and in dairies this may

Fig. 6 — Part of a Cherry-Burrell milk pump to show the type of fittings used in sanitary piping

be the cause of serious contamination of freshly pasteurized milk, with unpasteurized or even partially soured milk. This tendency has led to the development of special types of cocks for dairy manufacture such as the grooved-plug cocks having longitudinal grooves cut in the plugs. Thus when any milk leaks around the plug in the closed position it is led away instead of eventually finding its way past the valve into the pipe beyond, as is shown in Fig. 9.

Commoner forms of plug cocks for food work are those in which the hole of both plug and body is lined with a suitable material such as wood, tin, nickel, Monel, nickel-alloy, and porcelain or "glass" linings. One manufacturer employs several 10-inch porcelain-lined cocks on fruit juices. Another specifies bronze bodies with the holes tin-dipped and silver-plated. Durion cocks also are made.

Gate valves present designs that have a more important bearing on sanitation and cleanliness. They can be obtained either as solid-wedge or double-wedge gates with either inside or outside screws. For liquid products containing solids in suspension the outside screw construction, shown in Fig. 10, is preferable because places where the solids can be deposited are few and hence are more easily cleaned. For the same reason single solid wedges are better than double-wedge gates in food handling.

When pipe lines are flushed, all valves, regardless of type, should be repeatedly opened and closed so that the body of the valve will be properly cleaned out. Many plants make a serious error in failing to perform this simple operation.

Globe valves are not as satisfactory for food products as are other valves because they offer a greater impediment to the free flow of liquids and may cause deposition of solids that are in suspension as well as have pockets that do not drain easily, as shown in Fig. 11. Angle valves are essentially globe valves but offer a freer flow of liquid and probably are easier to keep clean.

Y valves combine many of the desirable features of glove valves with the free opening of the gate valve and are finding increased use in food handling. Their interior construction and design also facilitate easy cleaning and good drainage, as is illustrated in Fig. 12. If the valve had an outside screw it would be still better.

Many special valves are found in the dairy field, where excellent sanitary features must be combined with positive opening and closing. So-called "Safety Outlet" valves and "Leak Detector" valves come under this class. The illustration, Fig. 13, indicates, in part, what this class of valve will do. It simultaneously closes two valve seats in tandem and opens a drain between them to remove any liquid passing through via leaks due to wear. A steam connection is provided so that the interior can be steamed out and sterilized before reopening. A most important feature of nearly all such special valves is the ease with which they may be demounted for daily cleaning—a condition that is more easily embodied in dairy valves than in many other services because they do not require the rugged or heavy construction needed for high pressures.

Pumps for handling liquid food products range from the simplest, such as steam ejectors, through reciprocating plunger pumps, steam pumps, rotary pumps and centrifugal pumps. In the dairy field compressed air is now occasionally being used to force the milk through pasteurizing apparatus in order to avoid contact with a pump mechanism. The steam ejector is a relic of bygone days but unfortunately it is still in use in a few tomato plants at the present time. The principal objection to it is the large quantity of steam that is condensed in the liquid while it is in operation. Rotary pumps and centrifugal pumps are most commonly used for liquid food handling. For this service they are of small size and should be constructed so that they may be easily taken down for cleaning.

The reciprocating steam pump also is used in a great many food plants and handles not only liquids but even solids, such as whole tomatoes for chili sauce manufacture. This form of pump pre-

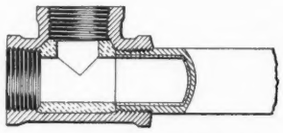


Fig. 7—A section of National Lead Company's tin lined piping

sents problems of cleaning different from those found in any other type of pump, as it is impossible to demount and clean it out as easily as could be wished. When in regular use it can be washed every night, first with cold water and then flushed out with hot water, and the operation repeated in the morning before starting operation, and no trouble will result.

If a period of days elapses between periods of use of this pump for handling liquid foods, however, it is highly desirable to open both ends of the hydraulic cylinders so that they will dry out after cleaning, and likewise remove the top of the valve chest and remove valves so that in case any film of residual matter remains behind, there can be no trouble from that source. A few hours spent in this way will save days of work later if by any chance the pump was not perfectly clean when laid up.

Practically all forms of pumps can be obtained constructed of suitable non-corrosive metals. Very recently a centrifugal pump has been put on the market constructed of stoneware that is virtually the equivalent of glass with respect to any possible effect on foods.

The wooden barrel continues to find considerable use in food plants as a permanent storage container for dry materials and frequently it brings trouble to its user, particularly if it is holding flour or other cereal products that are liable to insect infestations, for the bugs get into the cracks and multiply there. The remedy is to use metal

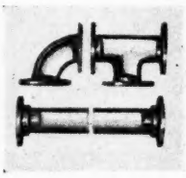


Fig. 8 — Glass-lined pipe and fittings from Limburg Enamelling Company.

containers with tightly fitting tops so designed that no cracks on the inside are present.

Wooden tierces, hogsheads, pipes and vats are much used in meat-curing cellars. Their design is satisfactory, but wood is not a perfect material of construction, for if its pores become infected with the wrong sort of bacteria it is a difficult material to sterilize.

Bins preferably should be of metal and in case the product is of a corrosive nature, like salt, the metal should be a non-corrosive alloy. Bottoms of bins are either flat or hopper type, depending on the desired manner of removing the materials. When hopper bottoms are used the slopes should be sufficiently steep to make them self-cleaning.

Two sorts of tanks—holding tanks and cooking tanks—are commonly used in the manufacture of foods. Bottom drainage, providing that materials will run out freely, is an important feature of design from the aspect of sanitation; see Fig. 14, which illustrates correct and incorrect bottom design of a cypress tank such as is often used for making tomato pulp or catsup.

Where tanks for cooking are used in batteries, it is not uncommon to find that they are improperly connected with the piping, and the net result is that washing out of such equipment is very difficult. In Fig. 15 are shown three common ways in which such equipment has been hooked up, only one of which is correct. Space prevents a discussion of why two of them are wrong, but anyone who is interested can study out the pipe connections and see why the methods are incorrect. One of the commonest faults in hooking up tanks,

kettles or vats is failure to provide a separate wash-out line to the sewers, so that whenever the equipment is cleaned, all the wash waters have to pass out through other subsequent equipment—a condition that usually causes expensive delays at the clean-up time.

Whenever tanks are used for cooking or evaporating purposes, the heat is transmitted to the contents through cooking coils, of which copper, nickel and Monel metal are the commonest materials of construction. In many instances the copper coils are "washed" with tin or are silver-plated, but in each of these cases the thin coating is not of a durable character and the usual cleaning operations will remove most of it within a comparatively few weeks or months. A new form of cooking coil has recently been provided by one of the equipment manufacturers, in which a metal coil has been coated with a glass-like substance which has the same coefficient of expansion as the metal itself. Under such conditions there is no chipping of the enamel or glass coating from the base metal due to thermal expansion, and therefore it offers a satisfactory protective enamel coating.

Cooking coils must be kept clean and bright regardless of the nature of the material from which they are constructed, and one of the important reasons for this is not one that has to do with sanitation and cleanliness but has to do with heat transfer, for a coil badly coated with cooked products is very thoroughly insulated and the rate of cooking is much reduced. The cleaning of cooking coils may involve only the use of a high-pressure spray of water, but usually requires scrubbing

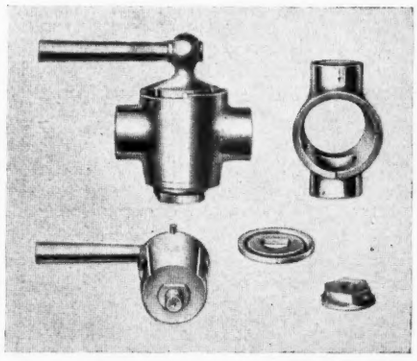


Fig. 9—Special plug cock — the Grooved Inlet Valve of the Creamery Package Company—with slots that lead away any possible leakage

with a soft brush, particularly on the bottoms, where the material always first cooks on. In extreme cases of burning it may be necessary to have workmen spend several hours scrubbing with wire brushes or scouring powders, steel wool and the like, to get the burned material off.

Such intensive scrubbing naturally will easily remove any plated material, such as silver or tin, which may be on the base metal, and hence nickel or Monel coils or coils manufactured from some of the other corrosion-resistant alloys will be much more satisfactory in the long run.

Both kettles and vacuum pans usually have curved bottoms that automatically eliminate drainage problems. Methods of connecting up with sewer lines for washing out the apparatus after use are essentially the same as embodied in the installation of cooking tanks. Kettles are made from copper, nickel, cast iron, or aluminum and, in the case of copper, may be lined with washed tin or block tin. Naturally, other materials of construction can be used but they are seldom found in the food field, with the exception of iron kettles and cookers frequently found in meat-packing plants, and the newer glass-lined steam-jacket kettles.

Cleaning the bowl of a kettle is a simple matter, owing to the large area and free access which it affords. Burning of kettles sometimes occurs and this involves patient, careful scrubbing in order to remove the coating of material, which if allowed to remain may cause the presence of black specks in the food products, a burned flavor, or a retarded rate of heat transmission, which slows down production very materially. Washed-tin linings quickly disappear under heavy scrubbing during clean-up periods, and for that reason the block-tin lining is much superior.

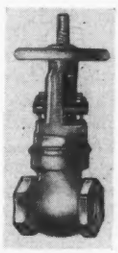


Fig. 10—Outside screw valve

Vacuum pans for food work are constructed of copper, nickel, and glass-lined steel, both with and without jackets and with and without heating coils and calandria. The problems of cleaning vacuum pans in the confectionery industry, as well as the preserving industry, are not particularly serious owing to the low temperature and the fact that all the products are soluble in water. Scaling will occur in sugar refining, and there are a number of ways that this may be removed, most of which require scrubbing with brushes and occasionally actual chipping. It has been reported that heating the coils or tubes with live steam with the pan empty will cause an expansion that will loosen scale in such cases.

In the dairy field the temperature of vacuum-evaporation is so low that although milk-stone might have been deposited in higher temperatures, none is formed here and the pans usually are easily cleaned with brushes and the usual detergents. Tomato-paste manufacture is partially carried out in vacuum pans without involving any special problems of cleaning unless burning has occurred, and in such instances there is no difference involved between cleaning a pan and cleaning a kettle.

Pasteurizers for bulk liquids are used in a variety of food products but find their greatest employment in the dairy field. Other uses are found in the fruit-juice and beverage industry as

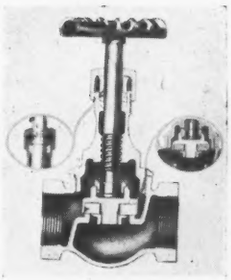


Fig. 11—Section of a globe valve showing the places where food may lodge and be difficult of removal

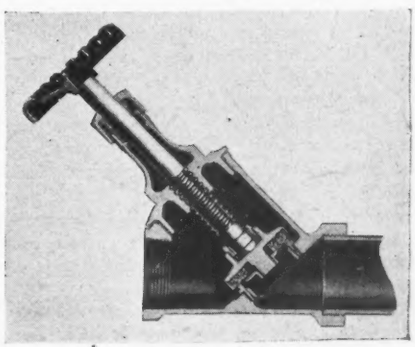
well as in vinegar manufacture. The problems of design of pasteurizers are greatest in the dairy field, and the present trend of design has to do with accessories, differing from the older forms, such as the elimination of the submerged stuffing box, which has always been one of several sources of possible re-infection of pasteurized milk. In some of the newer designs driving shafts are suspended vertically and the equipment revolves in a vertical plane instead of in a horizontal one.

The special valves found commonly in the dairy field are largely in connection with pasteurizers, and their particular function is to form an effective closing device that cannot possibly be a source of re-infection of the milk, which has already had its bacterial count greatly reduced by the heat treatment.

The heater is a form of dairy equipment by means of which the temperature of the milk entering the pasteurizer is quickly raised to the pasteurizing temperature. The design of the whole heating arrangement, together with its heat-transfer equilibria, has an important bearing upon the sanitation and cleanliness of this equipment in a rather peculiar way. Formerly, water at 170 to 180° F. was used in the coils to preheat the milk. This coil temperature is sufficiently high to cause the deposition of milk-stone or cooked milk on the tube, and in removing the milk-stone the tin coating usually is eventually stripped off, leaving bare copper, if the tubes are of tinned copper, which should never come in contact with milk.

The present trend of design by one equipment manufacturer is an effort to cut down the temperature difference between the heating medium and the milk itself. This concern has succeeded in raising milk to a temperature of 145°

Fig. 12—Section of a Jenkins Y valve that is much used in food handling. Note the absence of pockets in the valve body



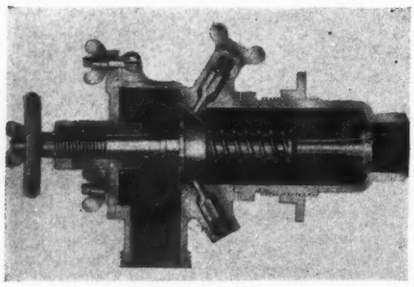


Fig. 13—A special valve from the dairy industry—the "Safety" Outlet Valve—made by Creamery Package

with the water on the other side of the tube being only 1° hotter, and has accomplished it by a two-stage heating, in which milk at room temperature or below is raised to 120°, and in the second stage is brought from 120 to 145°.

This remarkable heat exchange is made possible in the second stage by the circulation of a relatively great volume of water at 146° in the ratio of approximately 40,000 gallons of water per hour to 5,000 gallons of milk per hour. Equipment having this feature embodied in it does not deposit milkstone, and naturally the protective-coating surfaces of the coils remain intact for a much longer period of time.

Heaters, or preheaters, occasionally found in the tomato-products industry, present no similarity whatsoever to the heater used in the dairy field. In the tomato-products plant the heater is really nothing more than a cross of perforated pipe in the bottom of the tank, in which live steam is blown into tomato juice to bring it up to boiling temperature before sending it to the cooking tanks or kettles. Such a practice involves only those problems which might possibly arise from foreign material being blown in with the steam, such as dirt from pipes, or slugs of dirty water, but by properly trapping and straining the steam this point could be eliminated. It is not a problem of any magnitude, however, for it is very seldom met.

The cooler is a form of heat exchanger that finds its greatest use in the dairy and beverage fields. The form of service imposed upon this equipment in the beverage field usually is only that of cooling water, and the interior of the tube is either used for direct-expansion ammonia or refrigerated brine—usually the latter. In the dairy field, as usual, the most important service is found, namely that of chilling milk from the pasteurizing temperature quickly down to a temperature which will be too low for bacteria to multiply rapidly. Both direct and regenerative coolers are used. Tin-coated copper is the commonest material of construction and is satisfactory as long as the tin coating lasts, but eventually constant cleaning will expose bare spots of copper, which, of course, must then be retinned.

A new trend is found in the design of coolers, for in the past it has been found that the expansion stresses caused by the extremely cold liquids on one side of the tube and the warm liquids on the other sometimes cause leaks to appear in the joints between the tubes and the headers, so that water may escape and contaminate the milk. While the quantity of water getting into the milk in this fashion usually is negligible, the same cannot be said of bacteria which gain access from this source. Therefore certain newer coolers are now being designed with headers so constructed that expansion and contraction cannot cause a leak. Fig. 17 shows a cooler of this type.

Bottle-washing equipment is found in almost every sort of plant that manufactures liquid foods and includes not only the dairy field but also beverage, preserving, vinegar, catsup, chili sauce and mayonnaise manufacture. The greatest problems of bottle washing are found in the beverage and in the dairy industry, for it is quite important that a bottle after passing through be not only chemically clean but bacteriologically clean or, in other words, sterile. As is usual, the larger problems are found in the dairy field. Formerly bottle washers in dairies were of the so-called case type, i. e., they washed the bottles in a case without removing them. If cases were painted, the alkaline cleaning solution would remove the paint—slowly, to be sure, but sufficiently to contaminate the wash water—and it has been reported that traces of lead have been found in milk that apparently could have gotten in in no other way than from the paint on the case that contained the bottles. Where case washers are used it is advisable that the cases be branded by burning rather than painted with identifying marks, if such are necessary.

The trend in the design of bottle washers, however, is toward what is known as the unit type and away from the so-called case type. The unit type of bottle washer handles the bottle as an individual unit rather than in a group. Research on bottle washing indicates the desirability of a period of dormant soaking in the cleansing solution before subjecting the bottle to the usual jet washing, for many of the substances that remain upon the returned bottle are such that they are not easily removed in haste.

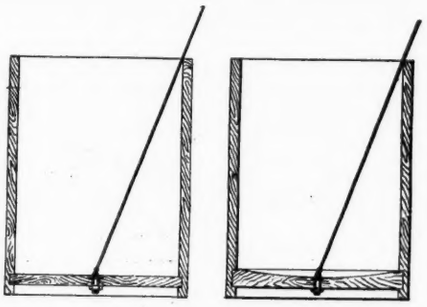
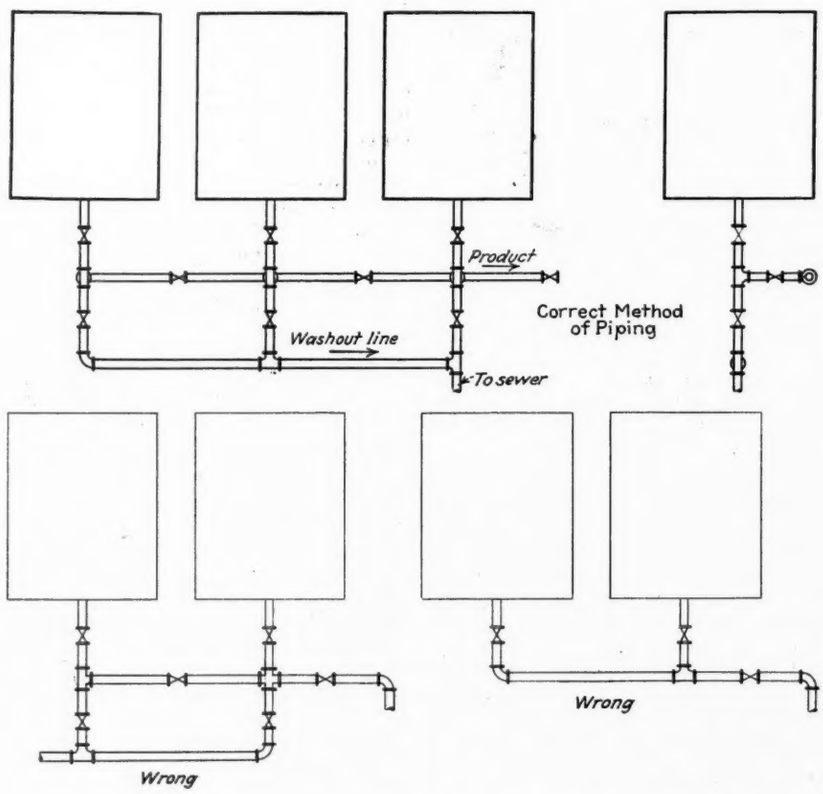


Fig. 14—Types of bottoms in cypress tanks. The curved bottom at the right is far preferable to the flat bottom at the left

Fig. 15—Correct and incorrect methods of piping tanks. Try to figure out how to wash out any individual tank in the "wrong" group when the others are in use



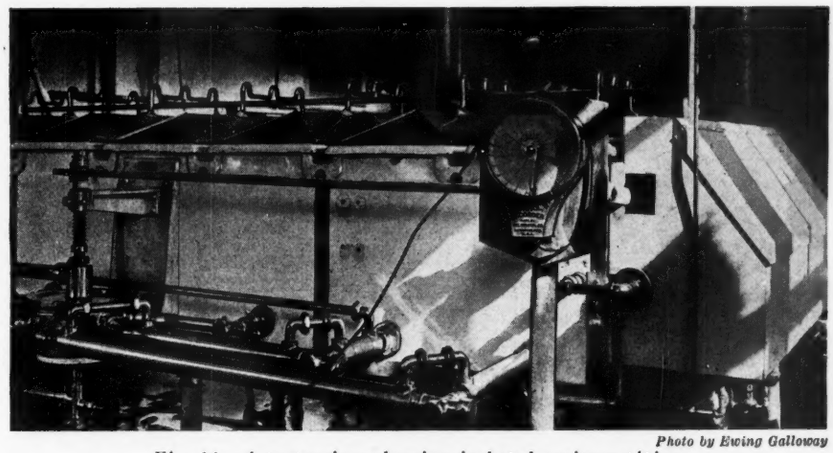


Photo by Ewing Galloway

Fig. 16—A pasteurizer showing jacketed sanitary piping

Like bottle washers, the can washer is undergoing a new sort of design which will involve washing not only the inside but the outside of the can as well. This is because of the fact that workmen taking milk cans or ice cream cans from washer usually will handle them at the lip and, if the outside is not clean, all the subsequent cans will be infected inside with bacteria. The milk can drier, which is beginning to make its appearance, merely blows dry air into the washed and sterilized can so that vapors which still remain in the interior air will be driven out. Otherwise, when cooled down they will condense in microscopic drops, or even visible drops, and unfortunately enough of the solids of the milk remain —even after the most careful washing— to afford a medium in which bacteria can grow. Therefore the effort is to keep the can so thoroughly dry that bacteria will not find the necessary moisture in which to multiply and thus furnish a heavy inoculum for fresh milk.

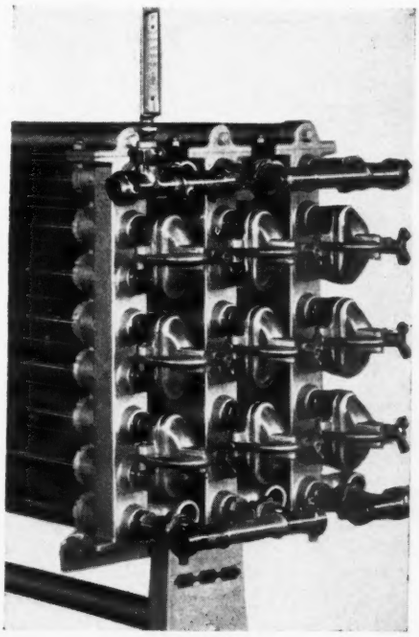
Can washers of another sort are used in the canning industry. Many of the older forms depended on a spray of steam or water, or both, to wash out the continuous stream of cans as they rolled past the proper orifices. They were open to the serious objection, however, that when steam pressures were employed that were adequate for the work the force of the blast was sufficient to prevent the cans from rolling by gravity through the equipment. A later design that has enjoyed much popularity embodies the principle of sprays for washing out the cans but also provides a positive mechanical drive that carries the cans steadily past the several cleaning stations. Dishwashing machines of the type used by large restaurants and hotels also are used for washing cans.

The churn is distinctly a piece of apparatus belonging to the dairy field. It is a curious fact that, with all of the research that has been applied in that industry, the churn has not been markedly changed with respect to its design in a great many years, because no satisfactory substitute has ever been discovered for wood as a material of construction. This is due to the fact that butter fat will stick to all metals but will not adhere to wood when it is wet. Being a wooden container, it is subject to all the troubles that wood can experience, for steaming will warp it, and therefore it cannot be sterilized by steam. Furthermore, wood pores are almost always saturated with materials absorbed during the churning process and afford an excellent medium for bacterial growth. It may be cleaned by only hot water aided by milk of lime or, preferably, the alkaline detergents.

Small churns are sometimes lined with crockery, but up to the present no substance other than wood is available for large churns. Owing to the peculiarities of butter fat, particularly with reference to its adhesion to any substance other than wet wood, the churn, sanitarily speaking, probably is the weak spot today in the whole dairy line of equipment.

Homogenizers and colloid mills are forms of equipment in food manufacturing that are largely used in the dairy industry. Both of them present peculiar problems of cleaning upon which design seems to have but little bearing at present. While it is not difficult to dismount and take apart the latest types of homogenizers it is practically impossible to finish cleaning perfectly a homogenizer operating on milk with any other product except milk itself and hence after the equipment is washed as well as possible, the best practice is to pump milk through it, until it no longer comes out discolored. Naturally, the discolored milk will not be used for human food.

Fig. 17—An internal tube cooler by Cherry-Burrell so constructed that no water can possibly leak into the milk



In the case of fillers designed for dry materials, no particular problems of design or manufacture are encountered except the desirability of smooth interiors that do not favor the retention of products. But in fillers for the handling of liquid foods, problems of design to facilitate cleaning are worthy of some attention. The present trend is toward fillers that are easily demounted or taken apart for easy cleaning, and the few that leave something to be desired as to accessibility are becoming less in number. Competition from the best designs of this form of equipment has stimulated a great revolution in design of all filling equipment, but in truth it must be admitted that sanitation has not been the only force at work. Saving of materials has been the important factor. Elimination of corners and pockets that cannot be cleaned out, of course, is a highly desirable feature of such equipment.

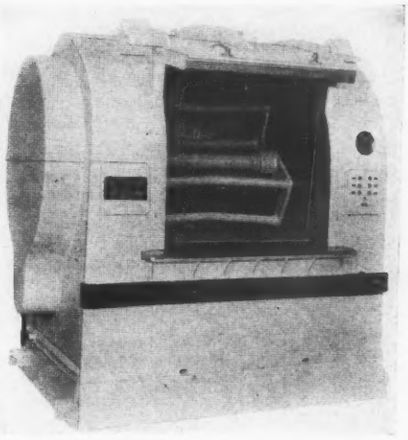


Fig. 18—A stationary bowl dough mixer by Baker-Perkins, showing the sliding front in the lowered position

Mixers of wet materials present a slightly more important problem of design than dry-material mixers although on the whole both are comparatively simple and involve only the provision of smooth surfaces to which nothing can adhere with any degree of tenacity. In many mixers the best design embodies revolving arms with a clearance that is extremely close—a feature that facilitates self-cleaning of nearly all the contents after every batch.

One of the latest designs of mixers is a departure from the tilting bowl, utilizing a stationary bowl with its front side slidingly mounted, as shown in Fig. 18. To dump a batch the side is

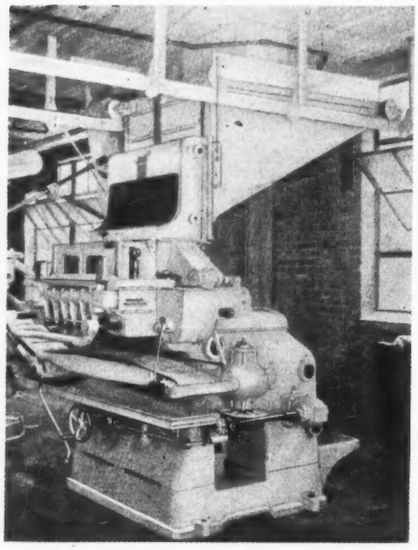


Fig. 19—A six-pocket loaf dough divider with the movable dough reservoir hung from an overhead trolley to facilitate cleaning

slid down, the machine started and the dough run out into the trough. Admittedly the most important feature of the machine is the greater safety to workmen, for many lives have been lost in cleaning dough mixers; but second only to this is its greater ease of cleaning on account of the shorter distance from front to back as contrasted with the longer distance from top to bottom even when the bowl is tilted.

Mixers of dry products are sometimes regarded as fool-proof, but experience has shown that it is important to see that the mixer is thoroughly cleaned out at frequent intervals. This is due to the fact that the revolving brushes or scrapers, or whatever device is used, do not always sweep everything clear before them, and occasionally during periods of idleness deposits of food remain, which may harbor insects, and subsequently re-infest all oncoming food materials, regardless of its previous good condition.

Proofers in bakeries once used canvas-covered trays that required frequent laundering but often became moldy. A more recent design is an aluminum tray the interior surfaces of which have been sand-blasted, with the result that the dough seldom sticks and the molding has been eliminated.

Dough dividers, for cutting dough to loaf-size lumps, are fed from a dough reservoir mounted above the divider. Two features are here embodied that facilitate design. In large units, shown in Fig. 19, the reservoir is hung from an overhead trolley so that it may be pushed aside to permit opening up the divider for cleaning. In small units the design is different; the feed hopper is tilted on a hinged joint, as shown in Fig. 20, to permit easy access for cleaning purposes.

Ovens involve very few problems of cleaning except those in which hearth breads are baked on a traveling plate oven. Such breads—rye, for example—are baked on a layer of cornmeal that sticks to the hot plates and if allowed to remain often accumulates in the oven and has been known to catch fire. A recent improvement is the installation

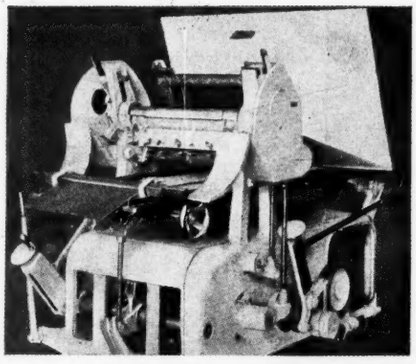


Fig. 20—Dough reservoir on a Baker-Copland cake depositor tilted out of the way for cleaning

of a revolving wire brush that removes the meal and discharges it into a suitable receptacle.

In the macaroni industry a serious problem is encountered in cleaning the dies through which the dough is pressed, for small bits of hard dough in the holes result in defective goods. Usually the dies are fished out of the bottom of the press cylinder and cleaned once a day. A recent invention makes it possible to clean the dies after every operation. In a new design the die is not an integral part of the dough cylinder but is separate from it and in contact with it only when the pressure from the hydraulic ram forces the dough cylinder into contact with the die by compressing the supporting springs. Therefore inspecting, cleaning or replacing the die is a simple matter that does not delay manufacture.

Combating "ROPE" in Dairies

By F. M. Scales
Sheffield Farms, Inc., New York City

LITTLE practical information on the ropy milk is to be found in the control of organisms producing literature of dairying. The author, therefore, has recorded here the procedure that was employed at a country milk-bottling plant where he was called as a consultant, in the spring of 1929, to combat a serious epidemic of this kind.

Ropiness in milk is caused by a bacterial growth and arises from a contamination entering the milk after it leaves the cow, whereas stringy milk is due to garget—a pathological condition within the cow's udder. The definition is given to make it clear that ropy milk contains no harmful bacteria, and also to show that the organisms producing this physical change in the milk are not pathogenic. In fact, ropy fermentation is favored in Europe in the preparation of certain fermented milks and in cultures used in the manufacture of Edam cheese.

An example of the extreme change that may be produced in milk by rope organisms is shown in Fig. 1, which depicts a three-day culture grown at room temperature. But, although the growth of the rope organisms in liquid milk are in no way harmful to health and impart no flavor, they do cause a physical change in the product to which the consumer objects. He will not accept milk in this condition, and, consequently, when trouble arises from a contamination with these organisms, drastic measures must be taken to remove them from the product.

No record existed of any previous epidemic of ropy milk at this plant, or even of any complaints on account of this condition. Formerly, the milk, after being weighed, was run into a 300-can storage tank and, without further cooling, was put through the pasteurizing process, which altogether. required about 4 hours. Milk was drawn off for pasteurizing as soon as a sufficient supply was in the tank. Just before this outbreak the 300-can insulated tank had been disconnected for repairs and a 100-can insulated tank, connected with an internal cooler, put in its place. The milk was thus cooled to around 45° F. and held for processing.

No change was found in the sanitary conditions on the farms that would favor the dissemination of these organisms. In fact, on some of them a rigid system of inspection had greatly improved their sanitary condition. On the others no changes were required, as the condi-

tions were satisfactory for producing milk of good quality. The investigation to be described later, showing that milk coming from different farms contained rope-producing organisms in varying numbers, forces one to conclude that in previous years they also may have been present—perhaps they are always present to some extent—but only under the particular conditions of last spring were they able to gain the ascendancy.

At this point, attention should be drawn to the fact that when a bottle of pasteurized milk containing only a very few rope organisms—the author hesitates to say only one or two, although such seems to be the case—is kept cool in the usual way it will become ropy; and the better it is pasteurized—i.e., the lower the bacterial count—the more likely rope is to develop, if any rope-producing organisms have survived pasteurization. This is chiefly because the other organisms that have been killed off are largely acid-producers. Acid is antagonistic to the formation of mucins or gums in the milk and may even cause the viscosity, due to these products, to disappear as it increases.

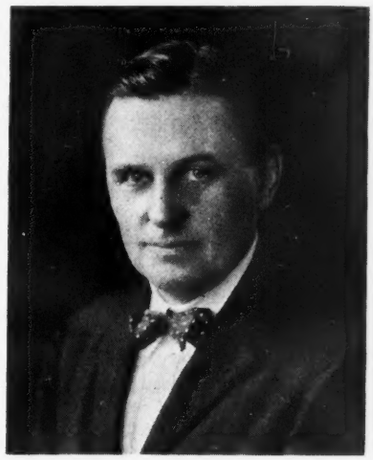
Heavy rains occurred in this locality in the spring of 1929, which created flood conditions in all the surrounding country, but similar conditions in previous years had not been associated with the trouble. The milk was shipped to a city about 250 miles away. From the distributing plant in that city came complaints of finding some bottles in a ropy condition. The country bottling plant was notified and, as far as possible, simple precautions were taken to prevent its recurrence.

One farm under suspicion was investigated and, on ascertaining that it was producing ropy milk, its product was excluded from the supply of the bottling plant and the farm given a very thorough cleaning and chlorinating. The rest of the bottled milk, in the meantime, went out to consumers for about a week without any further complaints. Then, with no apparent cause, a whole day's production went ropy. After the product was shipped for a few days more with no improvement, bottling was stopped completely, the milk was sent away to be separated and the cream churned. This was the condition of affairs when the author arrived at the country plant.

Samples of each farm's night milk were taken in the morning at the receiving platform in sterile 1-ounce vials and incubated at room temperature for 48 hours. At the end of 24 and 48 hours the surface, especially around the edge, was carefully tested with new toothpicks for traces of ropiness.

Samples of the same milk also were plated on standard beef agar plates in 1 to 100 dilutions with the addition of ½ cubic centimeter of sterile milk to the agar to promote growth. In this work the surface colonies of bacteria that develop were tested for ropiness with a sterile platinum needle, and, where found, were transplanted to agar slants for further study. As only the surface colonies are of value in this test an improvement of the technique employed would be to pour sterile agar plates containing the addition of milk and sufficient agar to make a stiffer medium—about 3 per cent—and then to inoculate the surface with a loopful or two of diluted milk and spread with a sterile glass rod similar to the procedure used in making Endo plates.

The first test on the milk samples in the vials after 24 hours indicated that some of the farms were delivering ropy milk. Where positive tests for rope were obtained, samples of water were taken from these farms and tested for rope-producing bacteria in the same manner as the patrons' milk samples. These water samples were obtained not only from the source of supply for the



F. M. Scales

farm but also from cooling vats, drinking troughs, creeks, ponds, and barnyard mudholes.

This test was made with vials or 4 ounce dilution bottles half filled with milk; but where a sufficient supply of Petri dishes is available the test may be made much more delicate by following the method devised by Dr. C. N. Stark, of Cornell University, of pouring sterile skim milk into a sterile Petri dish to a depth of about half a centimeter and inoculating it with the suspected sample. This gives a larger surface for growth to organisms which, although facultative anaerobes, attain their best development under aerobic conditions. In this case the milk should be tested all around the edge, as well as over the surface, for the ropiness will be in colony formation in the liquid, but with no change in the appearance of the milk to indicate its presence, except that of the ropiness, which is seen when the toothpick is raised from it.

While it was realized that more than one species of organism was very likely present, laboratory pasteurizing tests were run to determine what process, if any, could be used to kill these organisms in a sample of mixed milks.

In 1917 the author reported the differing morphology between young and old cells. (F. M. Scales: "A Preliminary Report on the Life Cycle of B. Coli," *Abstracts of Bacteriology*, 1,27, 1917.) Dr. J. M. Sherman and Dr. W. R. Albus in 1923 demonstrated some of the physiological differences between young and old bacterial cells, ("Physiological Youth in Bacteria," *Journal of Bacteriology*, 8,127-39, March, 1923), and more recently Dr. C. N. Stark has shown that old cells, over 24 hours old, are much more resistant than young, actively growing ones. In order to reduce the number of bacteria in a milk sample to a minimum in the regular 30-minute pasteurizing process at 143° F., he found it best to raise the temperature of the test medium to 80° F. and to hold it there for 2 hours before pasteurizing.

While such a procedure very likely would give satisfactory results, there are a number of objections to its practical application, of which two may be mentioned: first, it would not be in accord with Board of Health Regulations for the temperature of milk prior to pasteurizing; second, such holding multiplies the bacterial count about fourfold, which might outlaw the milk. However, since this incubating period of two hours makes the organisms more susceptible to the heat treatment, it was retained in the laboratory tests for comparison.

Samples of very ropy milks were obtained as they came in from the farms and were transported in about a half hour to the laboratory. Here they were mixed and portions were tested by pasteurizing as hereinafter outlined. Two sterile pint bottles were filled to within about an inch of the top and sealed with caps treated with chlorine solution. These served as controls. A little over a quart was pasteurized for 30 minutes at 144° F. and then cooled to 45° F. and bottled as before. Then 6 quarts of milk was raised to 60° F. and a quart immediately pasteurized at 144° F. for 30 minutes. The other 5 quarts after 45 minutes preholding was pasteurized at the same temperature for 30, 45, and 55 minutes. Two quarts of milk was heated to 80° F. and held at that temperature for 2 hours, after which the temperature was raised to 144° F. and held for 30 minutes. All pasteurized samples were cooled to 45° F. and bottled with the same precautions taken with the controls. Duplicate pint samples of each were taken as outlined and held at room temperature for 48 hours. The result of this test is shown in Table I.

Table I—Effect of Laboratory Pasteurization on Milk Known to Be Ropy, Processed for Different Lengths of Time at 144 deg. F.

Preholding Time	Temperature, Deg. F.	Holding time, Minutes	Rope After 24-hr. Incubation			Rope After 48-hr. Incubation		
Control	45	0	+	+	+	+	+	+
None	45	30	+	+	+	+	+	+
None	60	30	+	+	+	+	+	+
45 min.	60	30		+			+	+
45 min.	60	45		—			trace	
45 min.	60	55		—			—	
120 min.	80	30		—			—	

The longer holding period at 144° F. did not affect the cream line, for it was just as deep as in the samples held for the shorter time. The result of this test was next applied practically after the study of the samples of milk from the different farms had revealed the farms

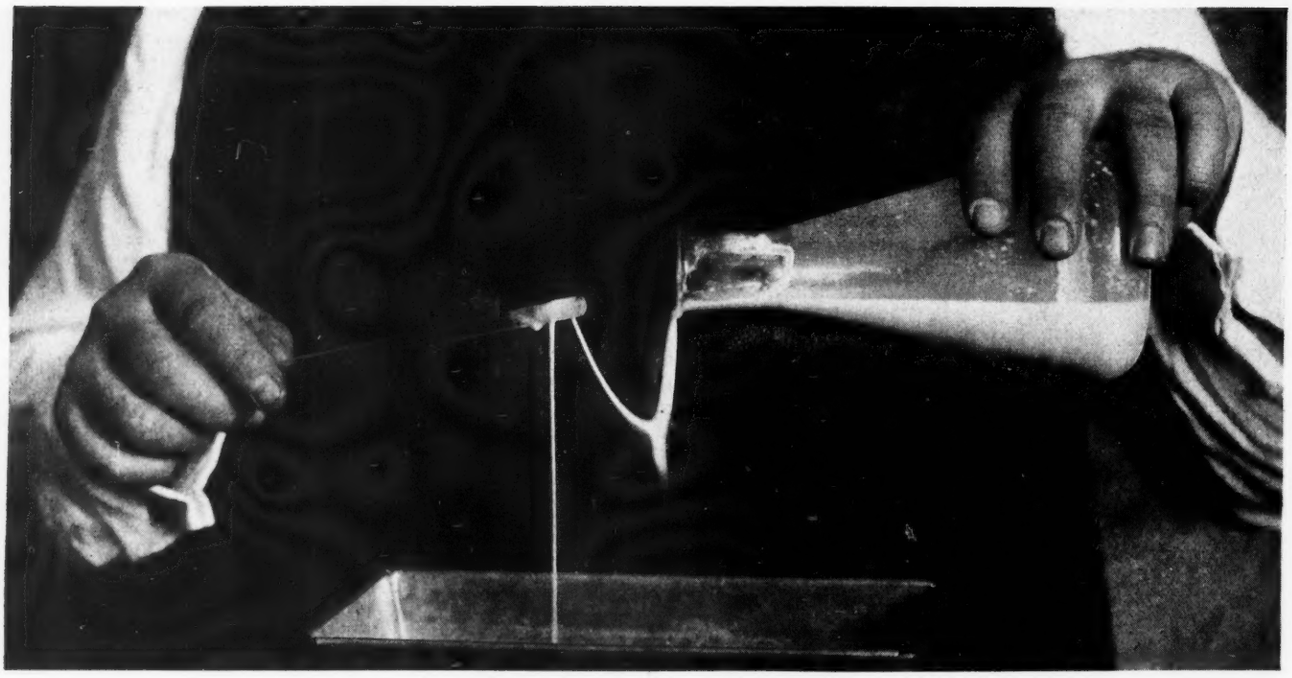


Fig. 1—A pure culture of a rope organism produces remarkable viscosity in milk

from which ropy milk was delivered to the bottling plant.

In testing the milk samples, both by direct incubation and by bacteriological plating-out, it was found that the former method of testing was more accurate than the latter, because out of 18 samples that became ropy in 24 hours, only 5 developed rope colonies that could be recognized on the plates. Failure to obtain colonies of rope organisms by the plate method from all the samples that showed their presence by the direct examination of the milk may be due to one of two factors: First, the number of rope-producing organisms in the fresh milk may have been so small that none was left in the 1 to 100 dilution used in plating. Second the organisms may have been among the subsurface colonies and so could not be identified. This fault in technique may be overcome by the change in method of plating previously suggested.

Tests of farmers' milk made on April 9 and 12 indicate a considerable fluctuation in the infection, as only 7 of the 20 positive tests found on April 12 were positive for rope on the previous test. Rope found on both occasions indicated that the farms had a well-established infection. Further tests showed that milk from certain farms regularly became ropy, while on others the infection appeared to be only intermittent. A third group of farms could be distinguished that produced ropy milk intermittently only after long intervals of production of normal milk.

Although the distribution of the organisms appeared to be widespread, the intermittent character of the ropiness from the latter group of farms indicated that the trouble was partly due to chance contamination. While the author has not had an opportunity to check up by isolating rope-producing organisms from water supplies, it is at least suggestive to note that of 11 farms that were supplying very ropy milk on a certain date 8 had creeks that were accessible to the cows and the other had springs in the yard during the freshet season.

It now became necessary to set up a control of the operations at the bottling plant. Since at the beginning of these remedial measures the milk that carried more than a trace of infection in a 24-hour test was to be excluded from the supply to be pasteurized, the simple recording system shown in Table II was established.

Table II—System of Recording Receipts While Combating Rope

Dairy No.	Date Tested	24-Hour Rope Test	Date Excluded	Date Returned
14	April 16	+	April 18	....
16	April 16	+ +	April 18	....
18	April 16	Trace	April 18	4/22
21	April 16	+	April 18	4/22
42	April 16	Trace	April 18	4/22
44	April 16	+	April 18	4/22
46	April 16	+ +	April 18	4/27
50	April 16	Trace	April 18	4/22
53	April 16	+ +	April 18	....
54	April 16	Trace	April 18	4/22
65	April 16	Trace	April 18	4/22
68	April 16	+ +	April 18	4/22
84	April 16	+	April 18	4/24
88	April 16	Trace	April 18	4/23
95	April 16	+	April 18	4/24
102	April 16	Trace	April 18	4/25
122	April 16	+ +	April 18	....
125	April 16	Trace	April 18	4/22
135	April 16	+ +	April 18	....
142	April 16	Trace	April 18	4/22
148	April 16	+	April 18	4/25
149	April 16	Trace	April 18	4/22

A strong positive, denoted here by + +, if obtained in 24 hours, would denote a very heavy infection, but in many samples, only a trace of rope could be found in this short time. On this date 36 farms were delivering ropy milk, but only the indicated 22 were excluded. Samples taken on April 16, and found ropy on April 17, could not be excluded before the morning of the 18th, when they came to the receiving platform. This system merely served to keep out of the supply that milk which continually contained a heavy contamination of the rope organisms or the supply which occasionally showed a heavy contamination. It must be kept in mind that a large supply that had traces of ropiness was being received and successfully pasteurized, along with an undetermined quantity of heavy contamination which slipped into the supply before the 24-hour test enabled us to exclude it.

While plating the milk samples has its value where it is desired to isolate pure cultures, the most satisfactory test for practical purposes at the plant and as a basis for the continued marketing of a part of the product is the simple collection of samples of milk from the different farms in sterile vials, and their examination for ropiness after 24 and 48 hours at room temperature. Where the infection is thus found to be heavy, such milk should be excluded from the supply until it has been demonstrated experimentally that some modification of the pasteurizing process will kill a sufficient number of the rope-producing organisms. This may be accomplished, as in the present case, by returning to the supply the milk from a few dairies at a time that show only a trace of rope after the modification of the pasteurizing process has been successfully demonstrated.

Holding the milk at low temperatures prior to processing makes the organisms more resistant to pasteurization, because of the consequent dehydration which takes place in their cells. Accordingly, for the best results, if the milk is to be held for any length of time before processing it should be kept at a temperature which will permit slow development of organisms. This will bring them to a condition where they are more susceptible to killing at the pasteurizing temperature. Where the period of holding before processing is short, the temperature should be raised to the point where it will induce growth in a shorter

time. The temperature and time should be so chosen that it will induce growth and so prepare the organisms for the most effective pasteurization, without permitting a great multiplication in the number present.

Those farms, which showed the presence of rope organisms on the place, by tests of the milk or water, were all given a very thorough cleaning and chlorination. In some cases this temporarily removed the trouble, but gave no indication of being of value for permanently eliminating the infection.

The favorable results obtained in the laboratory test indicated the future procedure that might be followed in the plant with a possibility of success. The milk used for this processing was from all of the dairies except a few of those that constantly showed a very ropy condition. Later, when the method of pasteurizing was operating successfully, the supply from 2 or 3 of the excluded farms was added every second day. This interval allowed a period of 48 hours to watch the finished product for the development of rope. The milk from those farms showing the least rope was the first to be added to the regular supply to be pasteurized. Milk from the few farms (less than a half dozen) that continued to be bad was kept out of the supply obtained from the other 135 farms until the ropiness began to abate. The system of recording shown in Table II was of aid in keeping track of the patrons' milk that was added to the main supply in this way. By following this procedure it was possible to return all the milk to the general supply without having any complaints about the finished product.

A trial batch was run in which the milk, as received, was directly heated to 144° F. and held for 30 minutes. Another batch was held for 45 minutes at a temperature of 58° F. and then pasteurized at 144° F. for 45 minutes. Samples of each batch were taken for bacterial determinations at the different steps in the process and the plates counted after 48 hours at 37° C. (98.6° F.) Two dilutions of each milk sample were prepared and then 3 plates were made from each dilution. The count per cubic centimeter given in Table III is the logarithmic average obtained from the 3 plates.

Table III—United States Public Health Service Standard Milk Control Code

Milk Samples	No Preholding Held for 30 Min. at 144 Deg. F. Count per c.c.	Preheld for 45 Min. at 58 Deg. F. and Then Held for 45 Min. at 144 Deg. F. Count per c.c.
Raw.....	75,000	
Entrance to heater.....	75,000	Lost After Preholding for 45 Min. 115,000
Outlet of cooler.....	9,000	4,000
Outlet of filler valve.....	8,200	3,750

It will be noted that the result of holding the milk for 30 minutes at 144° F. gave a satisfactory count in the finished product, but bottles of this milk held for 24 hours at room temperature were ropy. Unfortunately, the sample of raw milk belonging to the set that was preheld was lost, so no direct figures are available for determining the growth that had taken place, but, considering the figures obtained in the different stages of processing this batch, it is evident that growth had been initiated.

The initiation of growth, with perhaps slight multiplication, is the condition that should be obtained for beginning the pasteurizing process, because then the cell protoplasm has again taken up the normal quantity of moisture and so reacts at its normal thermal death point. A comparison of the counts obtained in the finished product of the two batches indicates that this condition was obtained in the second batch. Growth of the organisms so as to produce a considerable multiplication in their number would be an objectionable feature which, fortunately, may be avoided by processing in this way. Bottles of this product did not show any rope in 48 hours.

This satisfactory keeping of the product, however, apparently was dependent on the extent of the infection, for later some of the bottles processed in this way showed a slight trace of rope after 48 hours. While a slight trace of rope in this period of time is not seriously objectionable, as a matter of precaution it seemed best to lengthen the pasteurizing time by 10 minutes to a total of 55 minutes. This gave no reduction in the cream line. Another possible means of meeting this condition would be to raise the temperature of the raw milk to accelerate the change to the growing stage and thus have it a little farther advanced in the so-called preholding period.

In conclusion, it may be pointed out that all the evidence indicates that this trouble arose from organisms in creeks, pools, and barnyard mudholes. Fluctuations in the number of farms that deliver ropy milk and the degree of ropiness, which increased after rains, with a gradual subsidence as the dry period continued, were strongly indicative of this cause. There is little doubt that these organisms were in the supply going to this plant in previous years. The temperature and abundant rains of last spring certainly made the trouble very widespread and intense in this area, but the new storage tank in which the milk was precooled to 45° F. undoubtedly forced many of the organisms into the resistant stage, so that they were able to survive the pasteurizing process. Some of these organisms also grow at the lower temperature, hence there also was the possibility of slow multiplication taking place before, as well as after, pasteurizing.

Examination of patrons' samples for the purpose of temporarily excluding the most ropy ones until the right system of control is established, and then preholding the accepted milk for a short time, at a temperature high enough to induce a more rapid change of the bacteria to the growing stage, and employing a longer holding period at 144° F., seems to afford a flexible method of combating rope in various degrees of intensity.

Purifying Water for Food Manufacture by

OZONE

And "Electrolytic" Filtration

By JONATHAN SHARP
Philadelphia, Pa.

WHETHER entering directly into a food or used for washing food or containers, pure water is of utmost importance in maintaining a uniformly high-grade product. Of practically equal importance is it to have a wholesome atmosphere surrounding the food during the course of processing operations. Accordingly, air purification is receiving constantly increasing attention. Although but briefly suggested herein, there are many possibilities in the food industries for the use of ozone for water and air treatment and of the electrolytic method of water purification.

Because of its great chemical activity, ozone is a gas that is never transported in cylinders, always being generated by suitable electrical apparatus at the place where it is used. Ozone generators are now available[1] for various applications. They operate upon the principle of the passage of a high-voltage alternating current, called a corona or brush discharge, across an air space through which well dried air or oxygen is drawn. Modern generators have a glass tube of high dielectric strength to spread out the discharge evenly between the electrodes. When well de-

[1] Illustrations of apparatus used through the courtesy of the United States Ozone Company of America, Scottdale, Pa.

signed, the parts of a generator are rugged and easily replaced if necessary. Ordinary oxygen is converted by its passage through such apparatus to ozone the concentrated form in which three instead of two atoms are joined together as is indicated by the formula O_3.

When thus produced ozone is mixed with a large percentage of oxygen or air. Its chemical activity is so great, however, that a small rubber band stretched between the fingers in such an ozonized atmosphere snaps apart in a few seconds by virtue of its extremely rapid disintegration. Ozone has a great affinity for all organic matter, which accounts for its effectiveness in sterilizing and in oxidizing impurities. Substances other than water and air are often benefited by treatment with ozone. For example, cotton bleached by exposure to ozonized air takes on a wholesome odor of cleanliness, suggesting freshly laundered linen being sunned. Utensils and containers made of wood, metal, or glass, when rinsed with freshly ozonized water, tend to keep the same odor of freshness, which is necessary to preserve delicate flavors in foodstuffs.

One precaution should be observed in applying ozone to food sanitation. Some foods, including milk and butter, when they are exposed to high concentration of ozone such as that coming direct from the generator, are likely to develop an unpleasant taste. For this reason the use of ozone is limited usually to the removal of bothersome last traces of impurities from water and similar operations, or else only for the freshening of air, in which case the concentration of ozone must be low enough to be breathable. Disagreeable tastes are not caused by this manner of exposure.

Ozone treatment of water has been found highly effective in destroying the objectionable tastes and odors that occur at times or prevail in many water supplies. Typical examples are the removal of leafy color and taste, and of the chlor-phenol taste and odor from industrially polluted water that has been chlorinated. Such impurities usually are harmless but they give rise to unpalatable taste and odor.

FOODS processed with impure water may carry the taste or even intensify it. Industrial pollution of streams is an increasing threat to modern life. In industrial areas most water sources are polluted with sewage and factory wastes, and the effects are noticeable at certain times of the year in spite of most thorough, large-scale treatment by municipal water works. Automatically operating ozone water purifying equipment which will operate successfully with no attention is now available in almost any capacity. Besides delivering an aesthetically pure or palatable water, this equipment can also be depended upon to sterilize a water of questionable safety with such effectiveness that it will be entirely freed from all pathogenic organisms.

Where food spoilage or health is the main consideration with an impure water, ozone treatment probably is the most reliable of any means of water sterilization, covering the range of factory-scale operation to that of the small household. Because of its being readily adapted to automatic treatment ozone is given preference over other methods, which require considerable care and do not completely remove the personal element of danger. Ozone has an advantage over the ultra-violet method in that turbidity of the water will not diminish its effectiveness for destroying bacteria. Concerning the use of ozone-sterilized water to prevent spoilage of foods there is a caution that applies equally well to most other methods of water sterilization, whether that of boiling or otherwise. If spoilage is caused by mold, a single sterilization of the mold-contaminated water is not enough to be effective.

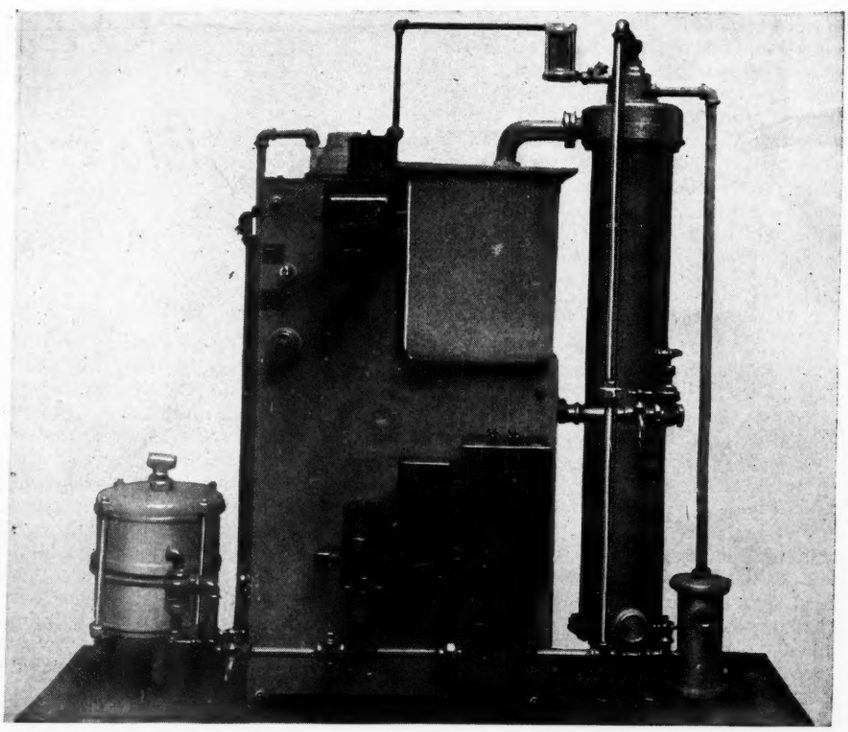
Spore-forming organisms are very resistant and, if well established, probably nothing less than a thorough clean-up of faulty conditions somewhere will eliminate them. Ozone tends to discourage mold growth, and the regular use of ozone sterilized water will go a long way toward keeping equipment sanitary, and thus preventing spoilage. Where contamination is carried into a plant by water bearing yeasts and molds, the best treatment of the water is a combination of the ozone and the electrolytic sterilizer methods, the latter treatment being essentially so effective a means for fine filtration as to retain mold spores as well as other organisms.

Fig. 1 illustrates an automatic water ozonizer rated at 500 gallons per hour capacity. Ozone generated by the tubes, which are mounted within the cast-iron frame together with the electrical parts for safety, is drawn into an injector at the top of the cylindrical mixing column at the right. The flow of water itself creates the flow of ozone, thus causing mixture of the two in proper proportions. Ozonized water stands at a given level in the glass-lined control tank and when drawn below this level the machine automatically refills the tank with ozonized water or maintains the level as long as there is any demand. The electrical parts that produce the ozone start operating automatically in conjunction with the flow of raw water into the apparatus. Once the storage tank is filled, no current is consumed until it is again necessary to refill it. An air drier supplying dry air to the ozone tubes is shown on the left. This or similar equipment, which may be on a much larger or smaller scale, when supplied with an additional filter containing crushed quartz or charcoal, will produce from almost any source a clear, colorless, sterile water of highest purity. Ozonation of a water having color frequently produces a slight cloudiness, and for this reason the filter following the ozonizer is recommended.

Equipment resembling the water sterilizers but provided with a blower and self-activating air drier is available for ventilating purposes and for treatment of air for cold storage. For the latter purpose the apparatus in the smaller sizes can be made portable for wheeling from one storage room to another. The quantity of ozone generated is controllable by a rheostat and is indicated by a dial meter.

The value of ozone in cold storage is shown by the greater freshness obtained with ozone in many stored products that tend to absorb odors from the air. Ozone materially reduces musty

Fig. 1—Automatic Water Ozonizer



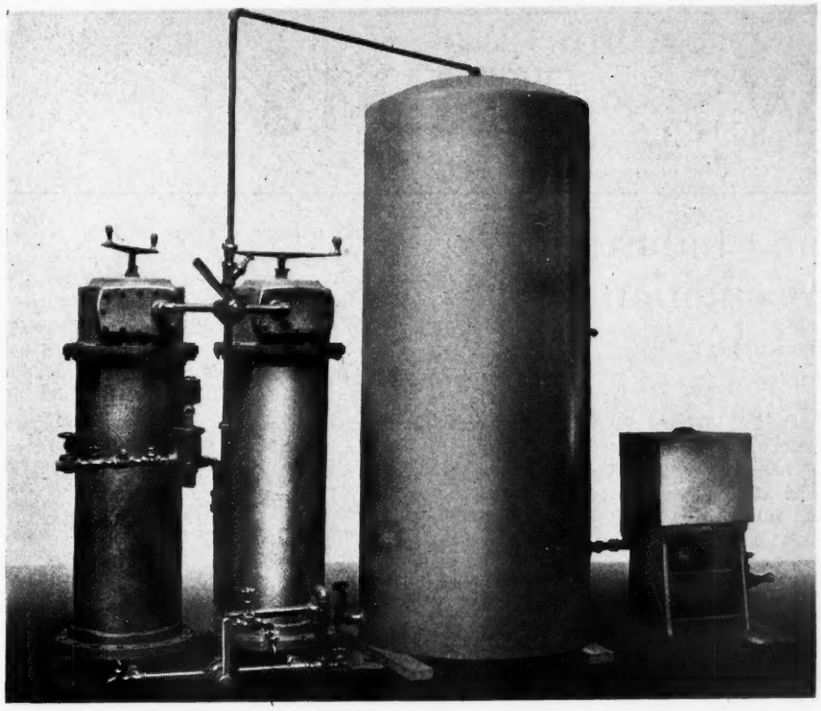


Fig. 2—Electrolytic Water Sterilizer

odors and is said to decrease the transference of odors between various products. When used regularly ozone has been found valuable in inhibiting mold growth in cold storage. Maintaining a dry atmosphere also prevents mold, but it allows shrinkage of goods by evaporation, which injures their value.

A number of large cold-storage plants use ozone in order to maintain a high enough humidity to prevent shrinkage and at the same time prevent an increase in mold growth. Many processes in which a food product is brought to a given state of dryness by the use of conditioned air could profitably have ozone added to the air-conditioning system to obtain a more tasty and better appearing product.

In the manufacture of beverages a sparkling, clear water is required, one that will remain free from cloudiness. Ozone treatment will stabilize some kinds of water by sweeping out gases that hold solids in solution. During treatment these form a precipitate, but remain clear after filtering. Some kinds of organic matter in water produce a light haze on ozonizing. In such cases subsequent filtration is advisable, but it is occasionally difficult to remove all suspended matter without adding a coagulating medium or filtering aid.

The electrolytic type of water sterilizer that automatically adds a coagulating medium by electrical means is in many cases preferable to other methods of treatment for fine turbidity. It is even effective for removing color, taste and odor. It is often used to follow up the ozone treatment when an unusually clear water is desired. When properly cared for, its exceptional filtering ability enables it to remove yeasts, molds, and bacteria, which are eliminated from the system daily by back-washing.

The filters are provided with rakes to insure thorough agitation of the filter bed during the flushing operation. It is necessary to freshen the filters, which contain a fine crushed quartz, at regular intervals by adding hypochlorite before back-washing. If the electrolytic treatment follows the ozone treatment the filters (or, in fact, any sort of filter placed here) will be found to keep sweet with less attention than otherwise, because of the small quantity of ozone carried to them from the ozone treatment. In this connection, it should be noted that any closed type of filter may itself be responsible for incipient contamination of the water, to the end that it is worse than before treatment, if not provided with means for back-washing or disposing of the collected impurities by flushing them to a drain, and also for frequent dosage with hypochlorite or some such sterilizing agent to sweeten it. This condition may occur before any appreciable pressure loss appears if the water is low in suspended solids.

The electrolytic water sterilizer first forms in the water by electrolysis (whence the name "electrolytic") a definite quantity of coagulant. When this fine suspended material, or floc, coagulates it serves to entangle smaller particles and is itself caught in the filters. The floc usually is formed from aluminum or iron plates by electrolysis of the water as it passes between them. A low-voltage direct current impressed across the plates, suitably arranged to give a large exposed surface, tears off microscopic bits of the metal, which appear during coagulation as feathery particles of aluminum or iron hydroxide. Despite their smallness, these particles have a large total surface. Because they uniformly permeate the whole mass of the water to be treated, unlike those coagulants that are formed elsewhere and incorporated by stirring, they sweep every drop of water free from impurities.

Alum cream, another name for aluminum hydroxide, is well known for its ability to hold colors. Just as it holds a dye as a mordant in cloth, so does it, or the corresponding iron hydroxide, hold fast to any color in the water, removing the color completely. In the same manner and due to its large exposed surface, it also removes by adsorption from the water any odorous substance or taste-producing material. A small volume of oxygen formed by the electrolysis has an additional purifying action upon the water.

Fig. 2 shows the arrangement of parts of an electrolytic water sterilizer having a rating of 500 gallons per hour. The electrode box in which the aluminum or iron floc is automatically added to the water when water is drawn through the apparatus is shown on the right. A motor generator supplies direct current of proper voltage, which may be adjusted according to the needs of the particular supply of water. A contact valve, similar to that on the ozonizers, starts the generator whenever purified water is drawn from the apparatus and lets it stop when the valve is closed, making the operation automatic.

THE large coagulation tank permits the electrolyzed water to stand relatively still long enough, even with full flow, to allow complete flocculation of the particles, which is necessary to prevent their passing through the filters. This tank in fact settles out by gravity the greater portion of the floc and its collected impurities. The floc remaining in suspension is then caught by the filters and the water is delivered under almost full pressure, the filters having been relieved of a large quantity of material by the coagulating tank. To eliminate the impurities the tank is designed to be sludged out daily when the filters are back-washed.

With a certain few kinds of water, having either extremely high or practically no mineral content, the electrolytic water sterilizer will not operate, but it can be adjusted to treat almost any other water with excellent results. As with the ozonizers, an examination of the water is made before installation to insure satisfactory performance and to determine the best running condition.

In conclusion, there are now available two excellent means of producing by automatic electrical equipment sterile, sparkling water of sufficient purity to meet the exacting requirements of food manufacturers. These cover the range of 100 to 10,000 gallons per hour capacity, with the possibility of higher or lower ranges if desired. The cost of maintenance is negligible and the first cost is not excessive, a household size of water ozonizer recently put on the market selling for less than one hundred dollars.

· NEWS · ITEMS ·

European Canning Industry In Promising Condition

By C. D. Trubenbach
Max Ams Machine Company, New York

THAT the canning industry in Europe is on the upgrade and is not going slowly, either, is my impression from a recent more or less limited survey of the situation.

In England the general public are increasing their consumption of canned goods. As in the United States, the British housewife is trying to emancipate herself from the drudgery of the kitchen and is gradually learning to help herself in this direction by relying to an increasing extent on canned foods. A great deal of popular prejudice against foods in cans still exists, which reminds the writer of the prejudices existing in this country a generation ago. There is, however, a capable, constructive leadership which is working for the benefit of the industry. The British government seems to be alive to the situation, through its Department of Agriculture, which is helping the canning industry. The National Food Council is in some respects a clearing house and is actively doing constructive work to educate the consuming public, the packer and the manufacturer.

A belief exists in prominent quarters that the commercial canners and can makers must adopt to a greater extent more of the best American methods if they are to prosper. An example of this is found in the pea-packing industry, notably the Wisbeck venture.

The British consuming public likes our California canned fruits. On account of the nature of their climate, there appears to be no danger that the local fruit packers can pack enough of quality fruit to threaten the demand for California fruits.

While there is a certain demand for canned tomatoes by the consumer in England, tomatoes cannot be grown there commercially on account of the climate. There is practically no demand for canned corn, for corn is almost unknown to the general public as an article of diet for humans. The English fish industry does not seem to be prospering to the same extent as the other branches of food industry.

The average food packer is handicapped by the lack of standardization of sizes. This makes for multiplicity of sizes, short runs, and tends to keep the prices of the cans up. Little evidence has been found as yet of a strong general demand for standardization of sizes.

In Belgium the outlook for canned foods is better than it has been in the past, but progress will be slow for a time until the standards of living of the so-called middle classes have risen. The largest Belgian packer is sold on the idea of quality goods and is packing excellent asparagus in quantities. Peas are packed in good quality and the pack is of considerable size. Mushrooms packed in Belgium are also of a good quality. The canners believe in modern American methods and equipment where they understand them and can afford to buy the equipment.

In the Netherlands the canning industry is quite important, considering the size of the country. Holland appears to be in a prosperous condition, but standards of living of that country must be higher before the consumption of canned foods will be of large proportions. Their milk industry uses modern methods and is doing a large export business. The American equipment manufacturer finds serious competition for the Dutch market from the German equipment manufacturer. Curiously enough, the German equipment manufacturer appears to sell more German equipment in Holland and other countries than he does in his own country. Some prejudice is found among Holland vegetable packers against modern American methods, and the claim is made that their own semi-automatic canning methods make for better quality. I could not see enough evidence to warrant agreement with their opinions. The canning industry in Holland, as in the other countries visited, seems to be handicapped through a lack of uniformity of sizes and non-uniformity of pack.

The average housewife in Germany cannot afford to buy much canned foods and, until prosperity is greater, the tendency to consume canned goods will develop less rapidly than in other more prosperous countries. The German government has made it more difficult by putting a high tariff on imported canned goods. Despite this, Germany imports a considerable quantity of canned pineapple from the United States and canned meats from the Argentine. The German government has shut off the market, at least temporarily, for California sardines by practically prohibiting their importation. The law in that country defines a "sardine" as a fish under 10 cm. (approximately $3\frac{7}{8}$ in.) in length. Reports in prominent quarters indicate that reciprocal trade concessions with the Norwegian and Spanish governments have influenced the German government to make rulings that exclude California "sardines."

Some of the leading German packers are trying to adopt the best American methods of canning as they understand them. They are handicapped by the European lack of standardization of sizes and lack of uniform quality of pack. The rate of growth of the canning industry in Germany is sure to depend, in a large degree, upon the prosperity of the country.

The writer found France, in general, prosperous. There was practically no unemployment and in some quarters there is even a slight labor shortage. The canning industry appears to have an excellent future in France. A surprising number of packing and can-making plants are found there. The canning industry, however, as in the rest of Europe, is handicapped by the lack of standardization of both pack and cans.

France, however, is more self-contained from the standpoint of the canning industry than most European countries. Due to difference in language and temperament, and consuming power, the prospects for a large volume of business for the American manufacturer in the immediate future are not too encouraging. The largest pack in France is of peas. While they have not been using American methods for food packing, to a very large degree, they are gradually adopting them, and the trend is increasing toward the adoption of American methods. The French leaders like the modern high-speed American equipment and recognize the limitations of German equipment, despite its low cost and the claims of German manufacturers.

COMING EVENTS

OCTOBER

1–2—Bread and Cake Bakers' Association of Canada, Toronto.
1–4—Eighteenth Annual Safety Congress, Chicago.
7–8—Minnesota State Bottlers' Association, Minneapolis.
8–10—Wisconsin Buttermakers' Association, Chippewa Falls, Wis.
21–23—International Association of Ice Cream Manufacturers, Toronto.
21–26—Dairy Industries Exposition, Toronto.
24–26—International Association of Milk Dealers, Toronto.
26—Association of Pacific Fisheries, Vancouver.
28–30—Fourth Annual Convention, Mayonnaise Products Manufacturers' Association of America, Atlantic City.

NOVEMBER

11-15—American Bottlers of Carbonated Beverages, Atlantic City.
16–22—Pacific Slope Dairy Show, Oakland, Calif.
19–20—National Creamery Buttermakers' Association, St. Paul.
20-22—Association of Ice Cream Manufacturers of Pennsylvania and New Jersey, Atlantic City.

Income Tax Returns and Tariff Relief—Milling in Bond Privilege in Jeopardy—Other Countries Impose Stiff Tariffs

By Paul Wooton
Washington Correspondent
Food Industries

As this issue goes to press, the Senate only has begun to discuss the disputed items in the tariff bill. While the undisputed items have suggested much comment, the real battle over the tariff is just beginning as this is written.

In accordance with the provisions of a resolution adopted by the Senate, lists have been submitted by the Democratic members of the Finance Committee naming the companies whose income tax returns are to be requested. The list includes a number of concerns engaged in the manufacture of food products. Among them are: National Biscuit Co.; Shredded Wheat Co.; Loose-Wiles Biscuit Co.; Sawyer Biscuit Co.; Johnson Educator Food Co.; Quaker Oats Co.; Pacific Coast Biscuit Co.; Kellogg Co.; Corno Mills Co.; Postum Co., Inc.; Cream of Wheat Co.; Ralston-Purina Co.; Hecker H-O Milling Co., Inc.; Armour & Co.; Cudahy Packing Co.; Foell Packing Co.; Libby, McNeill & Libby; Oscar Mayer & Co.; Vette & Zuncker; Wilson & Co.; Corn Products Refining Co.; Atlantic Coast Fisheries Co.

The effort of the Senate Finance Committee to strike out the House provision requiring the payment of duty upon wheat imported for milling in bond, equal to any reduction in duty which by treaty applies to flour, was defeated. This leaves in the bill the House provisions which take away from American millers the advantages they have had by reason of the 30 per cent tariff preferential allowed to Cuba. In the opinion of the majority of the Finance Committee, this will have the effect of diverting much of this business to Canadian mills. It is argued that the Cubans have become accustomed to the flour made from Canadian wheat. On the other hand, the opinion prevailing in the Senate, proper, was that the American mills would hold most of their Cuban trade but would have to draw their supplies of wheat from American rather than Canadian sources. Under the provision approved by the Senate, Southwestern millers now will have an equal opportunity with those of the northern border in competing for business in Cuba.

Other Nations Apply High Rates

Foreign nations are busy finding fault with import duties proposed in the new tariff bill, but they are overlooking the inconsistency of their positions. There is no nation which does not resort to the use of tariffs and few keep them within the maximum bounds of American tariff laws. The U. S. Tariff Commission just has compiled tariff data from a large number of countries. The tendency to resort to higher and higher duties is everywhere evident. In its last tariff revision Argentina went about the matter boldly by increasing the duty on shoes 135 per cent; on cardboard, 105 per cent; on woolen textiles, 97 per cent; on unbleached cotton cloth, 76 per cent.

Australia has no hesitancy in assessing $194.40 on small motor cars, unless they come from British sources; then the duty is $145.80. Silk hosiery comes in for the modest levy of $2.64 per dozen pairs ($1.65, if British).

Austria, in addition to its stiff rates of duty, requires special import licenses for a wide range of commodities. A turnover tax has the effect of increasing all duties. Moreover, rates may be amended by government decree.

Denmark does not believe in halfway measures to protect its industries. At its last revision, the duty on cigars and cigarettes was increased 50 per cent; on electrical machinery 50 per cent; on furniture, 60 per cent; on salmon and trout, 400 per cent; and on candy, 900 per cent.

France, perhaps the principal objector to our tariffs, is no piker when it comes to levying duties on imports. The present rate on wheat is 53 cents a bushel; on flour, $1.42 per 100 pounds; on crude oil, $3.49 per barrel; on refined oil, $2.73 per barrel.

Germany is collecting $3.41 per 100 lb. at the Customs House on raw sugar. Duties on automobiles and textiles were stepped up 100 per cent at the last revision. Levies on dyes and colors were doubled and laces pay 100 per cent more than formerly.

The United Kingdom, of free trade fame, collects 33⅓ per cent on an ad valorem basis on such things as automobiles, watches and clocks, cutlery, gloves and tires. It has specific duties too; 4d. per gallon on gasoline; 6d. on mechanical lighters; 2s.9d. on movie films. Buttons pay 33⅓ per cent.

Italy is taking no chances on its macaroni industry. The duty is $2.27 per 100 lb. Typewriters are assessed 44c. per pound. On flour, $17.77 per 100 lb. is taken at the Customs House. Tires pay 13c. a pound. These examples of high duties could be augmented indefinitely.

Japan is ultra occidental in its tariff policies.

As a result of this study by the Tariff Commission, it now will be possible to ask embarrassing questions of those Senators who essay to bring forward the complaints of foreign nations.

Chemists Consider Food Problems

The chemical problems of the production of flour and bread and some important developments in dairy chemistry were considered at two special sessions of the agricultural and food chemistry division of the American Chemical Society, which met in Minneapolis during the week of Sept. 9. A group of papers in the first of these two gatherings emphasized the importance of chemical control in wheat breeding and agronomic practice, as well as in the purchasing and milling of grain and in the manufacture of bread, biscuit, crackers, cake, and other baked goods. The program was organized by Prof. C. H. Bailey, of the agricultural biochemistry division of the University of Minnesota. Other speakers who presented papers were M. H. Blish, R. C. Sherwood, C. O. Swanson, C. G. Harrel, and A. A. Schaal.

The other divisions of the society also met at Minneapolis with a total registered attendance at the convention of about 1,200 members and guests. Several hundred technical papers were presented at the various sessions, abstracts of which are all available from headquarters of the society, Mills Building, Washington, D. C., for $1 per set. Those who are urgently interested in any part of the society program probably will find it most convenient to review details of special importance by procuring the abstracts and making subsequent direct contact with the various authors, because many of the full reports will not be published for several months to come.

Conducts Extensive Cold Packing Experiments

The Everett Fruit Packing Co., Everett, Wash., is conducting one of the most extensive experiments on cold packing of fruits and vegetables so far made. Up to date, strawberries, loganberries, raspberries, blackberries, Royal Anne, black and sour cherries, peaches, apricots, pears, melons, avocadoes, beans, and peas have been frozen for test and other varieties will be frozen as they come on the market.

No one method of freezing is used. The experiments are being made at various temperatures in cans, vacuum tins and paper cups, with sugar, sirup or brine and without any of them. Later, packages of all types will be opened and studied as to their condition. Temperature effects are being studied as the packing goes on. R. A. Rudnick, of the research laboratory of the Continental Can Co., Chicago, is in charge of the experiments.

New Zealand Experiments With Vacuum Packing

Operating under the processes controlled by Vacuum Products (N. Z.), Ltd., of Wellington, New Zealand, experimental packs of butter and cheese, hermetically sealed in evacuated metal containers, have been made and shipped to England during the past year with results that indicate the commercial future of the process in that country. In New Zealand, where the surplus production of dairy products finds its chief outlet in the mother country, the quality of the products as ordinarily packed has frequently suffered on account of the long voyage in refrigerator ships. Shipments of butter in the vacuum packages have met with very favorable reception in London, where optimistic observers have expressed the belief that soon New Zealand butter can be sold at the same premium that Danish butter commands when of the same grade.

Shipments of cheese in the vacuum package have not yet been quite so successful, although it is believed that the difficulty will be easily overcome by further research. A certain amount of free moisture has been found on opening the containers, although the product was otherwise in satisfactory condition.

Among the chief difficulties which the vacuum package was devised to overcome were damage en route by mice, rats, and other vermin; too open texture and loose body, and the formation of a thick, unsalable rind. New Zealand cheeses exported to European markets in ordinary packages have been subject to minimum arbitrary deduction of 2½ per cent of the "box weight," and in some instances the deduction has been as much as 5 per cent—a form of loss which research is trying to avert.

Standard Brands Gets Widlar

Standard Brands, Inc., is in the process of acquiring Widlar Food Products Company, with its plants at Cleveland and Norwalk, Ohio, and Wiggins, Miss. This move will add coffee, tea and spices, canned corn, mayonnaise, pickles and condiments to the Standard Brands line.

NEWS IN BRIEF

W. F. Schrafft & Sons Corporation, maker of Schrafft's candies, has been sold to Frank G. Shattuck Company, owner of the Schrafft chain of stores in New York and vicinity, for a consideration of $13,235,000 in cash and stock.

General Foods Company has announced the purchase of A. S. Speiss Sales Company by Richard Hellmann, Inc. The Speiss company has been the distributing agent for Hellmann's mayonnaise in New Orleans.

Packaging of quick-frozen meats in consumer packages, also called hard-chilled meat-cuts, is still in the experimental stage, according to advice from Swift & Company.

National Dairy Products Co. has acquired Bryant & Chapman Co., of Hartford, by an exchange of 20,000 shares of National for 25,000 shares of the latter.

E. R. Durkee & Co. is now consolidated with the Glidden Co. The food business of the combined concerns is to be conducted as Durkee Famous Foods, Inc.

Trademarks, good will and patents are written down to $1 in the pro forma balance sheet of Standard Brands, Inc., a reduction of $17,956,106 in the case of Royal Baking; $3,839,526 for Fleischmann; and $244,987 for E. W. Gillett.

A substantial interest in Batchelder & Synder, Boston packers, has been acquired by Frosted Foods Company, Inc., a subsidiary of General Foods. Packaged meats frozen by the Birdseye process will be marketed.

Gorton-Pew Fisheries, of Gloucester, Mass., will have its new quick-freezing plant in operation in approximately another month. The Kolbe system will be used.

Seedless oranges from Chile were recently received in New York in a refrigerator ship. The shipment, comprising 50 cases, is the first on record. Damage incurred en route was less than 1 per cent.

Manufacturers and sellers of artifically colored cooking compounds are subject to a special tax by the Internal Revenue Department after Oct. 1. A United States District Court ruling in Missouri holds that they are subject to the special tax levied on manufacturers and dealers in colored oleomargarine.

Consolidated Dairy Products Co., of Seattle, becomes one of the largest co-operative dairy organizations in the world through the acquisition of the American Creameries, Inc.; Red Shield Co., Inc., and Bradner Co., all of Seattle. Nine-year-old Consolidated now has a yearly sales volume of $15,000,000.

Carnation Milk Products Co. is now engaged in the manufacture of pancake flour and cereal foods through its recent acquisition of the Albers Bros. Milling Co., with plants at Los Angeles, Oakland, Portland, Tacoma, and Seattle. The Albers unit will continue to operate independently.

A block of Beechnut Packing Co. stock, totalling 46,000 shares, has been transferred from United Cigar Stores ownership to Gold Dust Corporation.

Dry ice production has increased 340 per cent in 1929—from 50 to 170 tons per day. Six more plants are to be opened by the Dry Ice Corporation of America, giving a total capacity of 370 tons per day.

Bluepoints Co., Inc., is the new subsidiary of General Foods to take over the North Atlantic Oyster Farms, Inc., with its subsidiaries: Rhode Island Oyster Farm Co., Connecticut Oyster Farms Co., South Norwalk Oyster Farms, Long Island Oyster Farms, and Producers Sales Co. W. H. Raye, president of North Atlantic, will head the Bluepoints company. The Birdseye quick-freezing process will be used for putting out frozen packaged oysters.

PERSONAL

EDGAR H. STONE has been elected president of Syrup Products Company, a subsidiary of the Spreckels Sugar Corporation, at Yonkers, N. Y., devoted to the manufacture of industrial alcohol, carbon dioxide, lacquer solvents, and molasses.

PAUL PAYNE MOZINGO has resigned as production manager of the Vincennes Packing Co., Vincennes, Ind., and goes on Oct. 1 to the Kroger Grocery & Baking Co., at Cincinnati.

DR. LOUISE STANLEY, Chief of the Bureau of Home Economics of the Department of Agriculture, has accepted the position of professional advisor to the home economics department of the George Washington University. Dr.

Dr. Louise Stanley

Stanley brings a wide experience to her new post. She taught home economics for 16 years at the University of Missouri; acted as a home economics agent of the Federal Board of Vocational Education for several years, and has served in her present position of Chief of the Bureau of Home Economics since 1923. Her connection with George Washington University will be purely advisory.

W. LOWE WALDE has been appointed technical director of the National Preservers' Association to succeed C. P. Lathrop, who recently resigned to go to Curtice Brothers Company.

W. G. WESTRUP, assistant manager of the Quaker Maid Company plant at Brooklyn, will have charge of the new plant of that company at Terre Haute, Ind.

W. E. BROCK, president of Brock Candy Company, of Chattanooga, has been appointed United States Senator from Tennessee to fill the chair of the

late Senator Lawrence D. Tyson until the general elections of 1930.

CLARENCE WARD, formerly chemist of the Hunter Milling Company, at Ashland, Kan., has resigned and organized the City Bakery Company in that city.

GEORGE F. KROHA has been elected vice-president of the Pfaudler Company.

J. W. READ, formerly head of the department of agricultural chemistry of the University of Arkansas, and more recently a graduate student of cereal technology under C. H. Bailey at the University of Minnesota, joined the research staff of The W. E. Long Company, Chicago, consultants to the baking and milling industries.

THOMAS H. BLODGETT, president of American Chicle Co., and director of Snider Packing Corporation, has been elected a director of Chain Stores Development Corporation, a management and holding company.

J. J. LAVIN, formerly manager of the Sperry Flour Mill at Portland, Ore., has been elected president of the Royal Milling Company and the Rocky Mountain Milling Company, Great Falls, Mont.; and the Kalispell Flour Mill Company, Kalispell, Mont.—three of the units of General Mills, Inc. He succeeds J. W. Sherwood, retired, who also held the presidency of the three mills.

GEORGE B. WEAREN, of St. Louis, a director of the Coca-Cola Bottling Co., has been elected to the directorate of Chain Stores Development Corporation.

SYDNEY ANDERSON, former member of Congress and chairman of the House Committee on Agricultural Appropriations, is resigning from the executive leadership of the Millers' National Federation to become affiliated with General Mills, Inc.

OBITUARY

LAWRENCE HUGHES, 47, founder of the Hughes Ice Cream Company, Los Angeles, Calif., died Sept. 7, of complications following an appendicitis operation at the Good Samaritan Hospital in Los Angeles. When the Hughes Ice Cream Company was merged with the Golden State Milk Products Company, about a year ago, Mr. Hughes, then president of the former company, became manager of the San Francisco and Los Angeles ice cream business for Golden State.

FREDERICK C. BITLER, aged 37, Bronxville, N. Y., wholesale baker, died Aug. 25 from a blood clot in the coronary artery.

MATHIAS FRANK, 43, meat packer and wholesaler, of Columbus, Ohio, committed suicide by drowning in the Scioto River there, Sept. 6. Mr. Frank had been failing in health for several months, to which fact his act was ascribed. He was born in Baden, Germany, and had been in the meat business in Columbus for 20 years.

HARRY SHETSKY, president of the Northwestern Beverage Company, died of pneumonia in Chicago, on Aug. 24. He was 37 years old.

F. R. BURROWS, 67, of Swift & Company, Chicago, died Sept. 4 after a year's illness. He had been in the meat business since he was 16.

CHARLES H. STEPHENSON, microanalyst with the Bureau of Food, Insecticide and Drug Control for more than 20 years, died in Buffalo on Sept. 11 at the age of 47. He had retired in May, 1928, because of ill health, and returned to his native city. Mr. Stephenson became associated with Dr. Harvey W. Wiley in the Bureau of Chemistry in 1907. His name will be recalled as closely associated with B. J. Howard, chief of the microanalytical laboratory, with which he served until his retirement.

DR. FRANK H. CHITTENDEN, 70, senior entomologist in the Bureau of Entomology, U. S. Department of Agriculture, died in Washington on Sept. 15. He was best known for his investigations of insects injurious to truck crops.

· NEW · CONSTRUCTION ·

Factory and Equipment Requirements

Abattoir Building—City of Jabett, Que., A. L. Marselais, Clk., is having plans prepared for the construction of a civic abbatoir building. Estimated cost $100,000.

Bakery—Barker Baking & Candy Co., Bismarck, N. D., has work under way on the construction of a 2 story, 90 x 125 ft. bakery at Main St. between 16th and 17th Sts. Estimated cost $150,000. J. Larson, Bismarck, Contr.

Bakery—A. M. Bauer, 388 Wallabout St., Brooklyn, N. Y., had plans prepared for the construction of a 1 story, 60 x 150 ft. bakery at 212th St. and Jamaica Ave., Jamaica. Estimated cost $27,000. Architect not announced.

Bakery—Economy Grocery Co., M. Joseloff, East Hartford, Conn., awarded contract for a 3 story, 70 x 200 ft. bakery and 4 story, 60 x 160 ft. warehouse at Hartford to Turner Construction Co., 178 Tremont St., Boston. Estimated cost $175,000.

Bakery—Fischer Baking Co., 242 Livingston St., Newark, N. J., is having plans prepared for a 2 story bakery, etc. at Railroad and 5th Ave., Asbury Park. Estimated cost $150,000. W. E. Long Co., 155 North Clark St., Chicago, Ill., is architect.

Bakery—Franklin Bakery, L. Rosen, 17 Nestor St., Franklin, N. J., is receiving bids for the construction of a 2 story, 28 x 185 ft. bakery. Estimated cost $40,000. J. De Rose, 19 Ellison St., Paterson, is architect. Machinery and equipment including American ovens, Peterson ovens, mixers, dough machines, etc., will be required.

Bakery—Gottfried Baking Co., 534 East 72nd St., New York, N. Y., is having sketches made for a 4 story bakery at 11th Ave. and 51st St. Estimated cost $400,000. Architect not announced.

Bakery—Green & Green Co., Cincinnati St., Dayton, O., plans the construction of a 2 story, 90 x 197 ft. addition to bakery at Cincinnati and Flubart Sts. Estimated cost $200,000. Private plans.

Bakery—Homestead Bakery, Corpus Christi, Tex., awarded contract for the construction of a 1 story, 36 x 88 ft. bakery to C. F. Law, 2755 McFaddin St., Beaumont. Estimated cost $30,000.

Bakery—Jackson's Bakery, 46 Leeming St., Hamilton, Ont., awarded contract for reconstruction of 2 story bakery to Poag & Kemp, 9 Westinghouse Ave., Hamilton. Estimated cost $100,000.

Bakery—National Biscuit Co., F. C. Sears, Ch. Engr., 85 9th Ave., New York, N. Y., plans the construction of a bakery at Cincinnati, O. Estimated cost $2,000,000. Private plans.

Bakery—Superior Baking Co., A. E. Trafford, Pres., 587 South High St., Akron, O., plans the construction of a bakery. Private plans.

Bakery—Royal Baking Co., Salt Lake City, Utah, is having plans prepared for a 2 story addition to bakery. Estimated cost $60,000. Cannon & Fetzer, Salt Lake City, are architects. Equipment will be required.

Bakery and Warehouse—Terminal Distribution Construction Corp., Indianapolis, Ind., awarded contract for a 2 and 3 story bakery plant at Pennsylvania and Queens Sts., Newark, N. J., to E. M. Waldren Inc., 40 Park Pl., Newark. Estimated cost $300,000.

Bakery and Warehouse—Union Building Corp., Newark, N. J., will soon award contract for a 2 and 3 story bakery and warehouse at 10th and Tabor Sts., Philadelphia. Ballinger Co., 12th and Chestnut Sts., Philadelphia, is architect. Almar Stores, 925 North Front St., Philadelphia, is lessee.

Bakery and Coffee Plant — Skaggs-Safeway Stores Inc., 2101 Broadway, Kansas City, Mo., awarded contract for a 4 story, 100 x 140 ft. bakery and coffee plant to John Thompson Construction Co., 114 West 10th St., Kansas City. Estimated cost $200,000.

Bakery and Coffee Roasting Plant — Bird Stores, Inc., A. S. Bird, Pres., 2101 Broadway, Kansas City, Mo., awarded contract for a 4 story bakery and coffee roasting plant, to J. T. Thompson Construction Co., Huntzinger Bldg., Kansas City. Estimated cost $200,000.

Bottling Plant—Aberdeen Coca Cola Bottling Co., Aberdeen, Miss., plans the construction of a 1 story bottling plant.

Bottling Plant—Coca-Cola Co. of Canada, Ltd., 37 Vallee St., Montreal, Que., plans the construction of a bottling plant on Beelecharse St. Estimated cost $75,000.

Bottling Plant—R. D. King, 1124 Van Nuys Bldg., Los Angeles, Calif., Archt., is receiving bids for the construction of a 1 story, 70 x 100 ft. bottling plant on Hollenbeck Ave., for G. J. House & Sons, 815 Ceres Ave., Los Angeles.

Bottling Plant, Power Plant, Etc.—F. B. Gray, 67 South La Salle St., Chicago, Ill., Archt., will receive bids until Oct. 3 for a 2 story bottling plant including power plant at River Forest for Bowman Dairy Co., River Forest. Estimated cost $300,000.

Candy Factory—Finder Bros., 1726 Walnut St., Chicago, Ill., awarded contract for masonry, etc., for a 1 story, 25 x 111 ft. addition to candy factory at 1730 Walnut St.

Canning Plant — Austin Brokerage Co., c/o C. A. Austin, Pres., San Perlita, Tex., has work under way on the construction of a 2 story canning plant at San Perlita, near Raymondville. Estimated cost $50,000.

Canning Plant—Tropic Fruit Products Inc., R. K. Haldane, Pres., Fort Myers, Fla., plans the construction of a grapefruit juice and pulp canning plant.

Canning Plant (Citrus)—Dilpako Packing & Canning Co., J. H. Myler, 192 Lakewood Ave., Detroit, Mich., plans the construction of a citrus canning plant at East and Franklin Sts., Clearwater, Fla.

Warehouse—Yorba Linda Citrus Assn., Yorba Linda, Calif., is having plans prepared for a 1 story, 100 x 360 ft. warehouse. Estimated cost $100,000. C. E. Noerenberg, Railway Bldg., Los Angeles, is architect.

Cheese Factory—Emporia Whole Milk Products Co., M. C. Kretsinger, Pres., Broadview Hotel Bldg., Emporia, Kan., is having plans prepared for the construction of a 1 story cheese factory. Estimated cost $23,000.

Cheese and Poultry Plant—Swift & Co., ft. N. Ft. Worth St., Fort Worth, Tex., plans the construction of a combination cheese and poultry plant at Taylor. Estimated cost $150,000.

Creamery Plant—Co-Operative Creamery, A. & M. College, M. C. Griffin, Mgr., Starksville, Miss., awarded contract for the construction of a 2 story, 106 x 150 ft. creamery plant to McArthur & McLemore, Starksville. Estimated cost $40,000.

Creamery Plant—Dairy Products Co., Kingsville, Tex., is having plans prepared for the construction of a 1 story plant at Alice. Estimated cost $75,000. J. Marriott, Frost Bldg., San Antonio, is architect. Complete machinery and equipment will be required.

Creamery—Fairmont Creamery Co., 12th and Jones Sts., Omaha, Neb., awarded contract for a 3 story, 84 x 128 ft. creamery on Noble St. to A. E. Skouby, Guthrie, Okla. Estimated cost $100,000.

Creamery—New Prague Co-Operative Creamery Assn., New Prague, Minn., awarded contract for the construction of a 2 story, 74 x 106 ft. creamery to Tapager Construction Co., Albert Lea, Minn. Estimated cost $50,000.

Creamery Plant and Produce Plant—Swift & Co., Packers and Exchange Aves., Chicago, Ill., awarded contract for the construction of a 1 story creamery plant at Macon Ga. Also soon takes bids for a produce plant at Ardmore, Okla. Estimated cost $75,000 and $150,000 respectively.

Creamery and Produce Plant—Land O' Lakes Creameries, 2201 Kennedy St., Minneapolis, Minn., awarded contract for a 2 story, 54 x 119 ft. creamery and produce plant at Thief River Falls to Bert Norby, Thief River Falls. Estimated cost $50,000.

Dairy Plant—Isaly Dairy Co. of Pittsburgh, C. Islay, Pres., 1033 Mahoning Ave., Youngstown, O., is having plans prepared for the construction of a dairy plant at 3380 Emily St., Pittsburgh, Pa. Estimated cost $200,000. McCormick Co., Inc., 121 South Negley Ave., Pittsburgh, Pa., is architect.

Dairy—Liberty Dairy Products Corp., Forbes and Boyd Sts., Pittsburgh, Pa., plans to rebuild 1 story, 40 x 80 ft. dairy at Braeburn Farm, New Kensington. Estimated cost $50,000. R. C. Huntsman, Bessemer Bldg., Pittsburgh, is engineer.

Dairy Plant—M. B. Dairy, c/o T. W. Fair, Mgr., Waco, Tex., acquired a site and plans the construction of a dairy plant at 17th and Franklin Sts. Estimated cost $250,000.

Dairy Plant—Parkside Dairy, 497 Belmont Ave., Fresno, Calif., plans the construction of a 1 story dairy plant at Roosevelt and Belmont Aves. Estimated cost including equipment $50,000.

Dairy Plant—Sanitary Dairy, A. Miller, Prop., 500 North 7th St., Grand Haven, Mich., is having plans prepared for addition to dairy, etc. Estimated cost $50,000. D. J. Lakie, 211 Peoples Bank Bldg., 28 8th St., Holland and R. F. Rockwell, 2160 Francis St., Grand Rapids, are achitects.

Ice Cream Plant—General Ice Cream Corp., Burlington, Vt., awarded contract for the construction of a 2 and 3 story, 40 x 100 ft. ice cream plant at South Winooski Ave. to V. A. Bergeron, 78 North Prospect St., Burlington.

Ice Cream Plant Addition—Bushway Ice Cream Co., Boynton Yard, Somerville, Mass., plans the construction of a 2 and 3 story addition to ice cream plant. Estimated cost $40,000. Architect not selected.

Ice Cream Plant Addition—General Ice Cream Co., 185 Main St., Cambridge, Mass., had plans prepared for the construction of a 3 story, 55 x 80 ft. addition to ice cream plant at East Cambridge. Estimated cost $45,000. K. W. Schantz, Inc., 78 Main St., Buffalo, N. Y., is architect.

Milk Plant—Pet Milk Co., J. A. Latzer, Pres., 832 Arcade Bldg., St. Louis, Mo., awarded contract for for the construction of a plant at Neosho, to Hug Contracting Co., Highland, Ill. Estimated cost $18,000.

Milk Plant — Twin City Milk Producers' Assn., J. A. Lapham, Mgr., 1001 Glenwood Ave., Minneapolis, Minn., awarded contract for the construction of a 2 story, 92 x 182 ft. milk plant at Farmington to T. E. Johnson & Sons, 5516 Lyndale Ave. S., Minneapolis. Estimated cost $100,000.

Cold Storage Plant—Crystal Ice Co., Mangum, Okla., will build a 500 ton cold storage plant. Estimated cost $75,000. Private plans.

Cold Storage Plant—Norfolk County Fruit Growers Assn., Simcoe, Ont., plans to erect and equip a cold storage and refrigeration plant for handling and storing apples. Estimated cost $100,000. F. C. Patterson, c/o owner, is architect.

Cold Storage Plant—National Ice & Cold Storage Co., Postal Telegraph Bldg., San Francisco, Calif., will build a 1 story cold storage plant at Hollister. Estimated cost $200,000. Private plans. Work will be done by day labor.

Cold Storage and Poultry Dressing Plant—American Produce Co., Gonzales, Tex., will build a 1 story cold storage and poultry dressing plant. Estimated cost $30,000. Private plans.

Cold Storage Warehouse—Scobey Fireproof Storage Co., 315 North Medina St., San Antonio, Tex., will receive bids until Nov. 1 for the construction of a 4 story, 100 x 156 ft. cold storage warehouse, and dry storage general merchandising fireproof warehouse, including refrigeration equipment, ammonia condensers, etc. Engineering Service Corp., Post Dispatch Bldg., Houston, is consulting engineer.

Ice Manufacturing Plant—Knickerbocker Ice Co., 41 East 42nd St., New York, N. Y., awarded contract for the construction of a 4 story ice manufacturing plant at 409 East 60th St., to Paul M. Sterling Co., 230 Park Ave., New York. Estimated cost $210,000.

Ice Plant—R. W. Alford, c/o Alford Creamery, 120 West Craig St., San Antonio, Tex., is receiving bids for the construction of a 50 ton ice plant at Mercedes. Estimated cost $80,000. Private plans. Electrically operated machinery and equipment will be required.

Ice Plant—E. W. Baker & Co., Medical Arts Bldg., Oklahoma City, Okla., is having preliminary plans prepared for the construction of a 10 ton raw water ice plant at Canton. Estimated cost $25,000. Private plans.

Ice Plant—Central Power & Light Co., Frost Bldg., San Antonio, Tex., awarded contract for the construction of a 50 ton ice plant at Elsa to R. E. Ewing, Harlingen. Estimated cost $35,000.

Ice Plant—The Ice & Fuel Co., W. R. Lowry, Mgr., 1421 West Federal St., Youngstown, O., is having plans prepared for a 2 story, 98 x 166 ft. ice plant. Estimated cost $250,000. G. R. Bright, 2615 12th St., Detroit, Mich., is architect.

Ice Plant—Louisiana Ice & Utilities Co., Alexandria, La., awarded contract for the construction of an ice plant including 1500 ton storage building, dairy storage building, ice manufacturing plant, etc. to P. Olivier & Sons Inc., Lake Charles. Estimated cost $61,703.

Ice Plant—Mustang Island Industries Inc., c/o G. B. Munsill, Pres., Port Aransas, Tex., awarded contract for the construction of a new electric light and 60 ton ice plant to L. Summeral, Corpus Christi. Estimated cost $110,000.

Ice Plant — J. W. Ross, Dyal Upschurch Bldg., Jacksonville, Fla., plans the construction of a 100 ton ice plant at Lake Wales. Estimated cost $200,000.

Ice Plant—Simpson & Morgan Ice & Coal Co., Rockmart, Ga., plans the construction of a 15 ton ice plant, electrically operated.

Ice Plant—Southern New England Ice Co., 75 Howard St., New London, Conn., had plans prepared for the construction of an ice manufacturing plant on Howard St. Estimated cost to exceed $40,000.

Ice Plant—Southern Utilities Co., Jacksonville, Fla., will build a 1 story, 80 x 160 ft. ice plant at Lake Wales. Estimated cost $200,000. Work will be done by day labor.

Flour Mills—Dracas Flour Mills, Streetsville, Ont., plans the construction of a mill. Estimated cost $75,000.

Flour Mills—Streetsville Milling Co., L. Orvist, Mgr., Streetsville, Ont., plans to rebuild flour mill on Main St. Loss $50,000. Complete new equipment will be required.

Grain Elevator—Canada Steamship Lines, 9 Victoria Sq., Montreal, Que., awarded contract for sub-structure of a grain elevator at Kingston, Ont., to Thunder Bay Harbor Improvement Co., 27 Cumberland St. S., Port Arthur, Ont. Estimated total cost $2,000,000. Complete equipment will be required. Bids will be received end of Nov. for balance of work.

Grain Elevator — Owner, c/o Chamber of Commerce, Dodge City, Kan., plans the construction of a grain elevator, 500,000 bu. capacity to Isley Lumber & Grain Co., Dodge City, lessee.

Grain Elevator—Galveston Wharf Co., 2324 B St., Galveston, Tex., awarded contract for piling and foundation for grain elevator to E. A. Whitney & Son, City Bank Bldg., Kansas City, Mo. Total cost $1,500,000.

Grain Elevator—Trans-Mississippi Grain Co., C. D. Sturtevant, Pres., 512 Omaha Grain Exchange Bldg., Omaha, Neb., plans to rebuild grain elevator recently destroyed by fire at 17th and Izard Sts. Estimated cost $500,000.

Grain Mill—J. B. Ham Co., 19 School St., Auburn, Me., will build a 1 story grain mill. Estimated cost $50,000. Edward Sales Co., 443 Congress St., Portland, Me., is architect. Work will be done by separate contracts.

Rice Mill—H. K. Smith, Wheatley, Ark., is having preliminary plans prepared for the construction of a rice mill. Estimated cost $150,000.

Food Products Plant—Quaker Maid Co., subsidiary of Great Atlantic & Pacific Tea Co., 420 Lexington Ave., New York, N. Y., awarded contract for a 6 story, 100 x 175 ft. plant at Terre Haute, Ind., to Glenn W. North Construction Co., 9th and Tippuane St., Terre Haute. Estimated cost $400,000. Food packing and baking equipment will be required.

Fruit Products Plant—Nesbitt Fruit Products Co., 768 South Ceres St., Los Angeles, Calif., had plans prepared for the construction of a 1 story, 40 x 100 ft. plant F. L. Stiff, 1101 Detwiler Bldg., Los Angeles, is architect.

Grape Products Plant—Castorina Argol Corp., S. Castorina, Pres., 1127 West 74th St., Los Angeles, Calif., plans the construction of a grape products plant at Cucamonga. Estimated cost $150,000.

Grocery Warehouse — Kroger Grocery & Baking Co., Florida St., Memphis, Tenn., awarded contract for the construction of a warehouse to Wessell Construction Co., 388 North Front St., Memphis. Estimated cost $127,000.

Grocery Warehouse—Western States Grocery Co., Salt Lake City, Utah, awarded contract for the construction of a warehouse to Jacobson Construction Co., Salt Lake City. Estimated cost $200,000. Former contract rescinded.

Pickle Factory—Oscar Wolff, 169 North Ada St., Chicago, Ill., awarded contract for the construction of a 113 x 120 ft. pickle factory at Lake and Ada Sts. to E. P. Strandberg, 232 East Erie St., Chicago. Estimated cost $85,000.

Potato Chip Factory—Potato Corp., c/o H. B. Heimerdinger, Mgr., Burley, Idaho, awarded contract for the construction of potato chip factory to H. M. Draper Constr. Co., Salt Lake City. Estimated cost $100,000.

Produce Plant—Central Wholesale Terminal Inc., c/o F. H. Swenson, Heard Bldg., Phoenix, Ariz., awarded contract for the construction of a produce plant to Austin Co., 415 Security Bldg. Estimated cost $300,000.

Produce Plant—R. E. Cobb Co., 2 East 3rd St., St. Paul, Minn., is having plans prepared for a 2 story, 100 x 150 ft. produce plant at John and Groves Sts. Buechner & Orth, 500 Shubert Bldg., St. Paul, are architects.

Sugar Refinery—Western Sugar Refining Co., 2 Pine St., San Francisco, Calif., awarded contract for a 1 and 2 story warehouse in connection with sugar refinery at 23rd St. to Barrett & Hilp, 918 Harrison St., San Francisco. Estimated cost $250,000.

Sugar Refinery Power Plant—Imperial Sugar Co., Sugarland, Tex., plans the construction of a power plant for present sugar refinery to include machinery and equipment. Private plans. Company selling 10,000 shares preferred stock to defray expense of construction.

Wine Vats—Jordan Wine Co. Ltd., Jordan, Ont., awarded contract for the construction of ten wine vats to R. E. McDonnell, Lister Bldg., Hamilton. Estimated cost $50,000.

Chicken Dressing Station and Packing Plant—Herndon Produce Co., Temple, Tex., awarded contract for a 1 story plant to Love Construction Co. Estimated cost $26,000.

Packing Plant—East Side Packing Co., 1214 North Second St., East St. Louis, Ill., will build a plant including 48 x 80 ft. killing building and 40 x 60 ft. rendering building. Estimated cost $60,000. Work will be done by separate contracts.

Packing Plant—McAllen Citrus Assn., c/o N. F. Donelson, Secy., McAllen, Tex., will soon award contract for the construction of a 1 story, 90 x 125 ft., packing plant. Estimated cost $40,000.

Slaughter House and Market—Rocco Mendaglia, 1200 East 224th St., New York, N. Y., awarded contract for the construction of a 51 x 75 ft. slaughter house and market at Ely and Gwan Aves. R. J. Marx, 3525 Eastchester Rd., New York, is architect.